PROGRAMMING DOCUMENTS

ENERGY ENGINEERING ANALYSIS PROGRAM

LIMITED ENERGY STUDY OF STEAM DISTRIBUTION SYSTEMS

HAWTHORNE ARMY AMMUNITION DEPOT HAWTHORNE, NEVADA

PREPARED FOR

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

PREPARED BY

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CONTRACT NO. DACA 05-C-92-0155

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
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Programming Documents

1. COMPONENT	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
Army		September 1995

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
Hawthorne Army Ammunition Depot Nevada	ECIP Modernize Industrial Area Steam Distribution

5. PROGRAM ELEMENT	6. CATEGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
	8000	40667	883.1

9. COST ESTIMATES

Item	U/M	Quantity	Unit Cost	Cost ($000)
Primary Facilities, replace various piping in concrete trenches and direct buried:				693.7
Manhole A5 to Manhole A9	LF	1,940	77.48	(150.3)
Rerouting for Buildings 3, 35 and 36	LF	1,316	108.94	(143.4)
East U Street Piping	LF	1,835	78.29	(143.7)
Family Housing Condensate Pipe	LF	3,599	71.24	(256.4)
Supporting Facilities	LS	—	—	0
Estimated Contract Cost				693.7
Contingency 10%				69.4
Subtotal				763.1
Supervision, Inspection and Overhead 5.6%				42.7
Design 6%				45.8
Unescalated CWE				851.6
Escalation to Midpoint of Construction: 1 December 1996				31.5
Total Request				883.1

10. DESCRIPTION OF PROPOSED CONSTRUCTION

Replace about 8,690 linear feet of steam and condensate piping in the Industrial Area. Replacement piping shall be installed to replace selected existing piping in shallow concrete trenches and direct buried installations. Existing deteriorated piping will be removed from concrete trenches; existing direct buried piping being replaced will be abandoned in place. For concrete trenches, new steam service piping will be schedule 40 steel pipe and new condensate piping will be schedule 80 steel pipe. Insulation and aluminum jacketing will be sized and field installed in accordance with the latest requirements of Corps of Engineers Guide Specification (CEGS) 02696, Heat Distribution Systems in Concrete Trenches. Piping to replace existing buried pipes will be preengineered conduit systems in separate conduits. Service pipes will be of the same type as in concrete trenches. Insulation and conduit will be as specified in CEGS 02695, Preapproved Underground Heat Distribution System.

Validation of savings: Energy savings will be measured by comparing the fuel consumption for the heating plant in building 13 before and after the new steam and condensate piping is installed. The heating requirements, including heating degree days and building utilization, will be taken into account when comparing the consumption values.

DD FORM 1391

11. REQUIREMENT: N.A. **ADEQUATE**: N.A. **SUBSTANDARD**: N.A.

PROJECT: Replace approximately 8,690 LF of selected steam and condensate return piping in the Industrial Area currently direct buried or installed in shallow concrete trenches.

REQUIREMENT: This project will contribute toward achieving Department of Defense facility energy goals of a 20-percent reduction in energy use per gross square feet by FY2000 versus FY1985 baseline levels.

This project will save $248,042 annually, comprised of $145,423 from fuel oil savings and $102,620 per year from maintenance cost savings. These savings result in a 3.43-year simple payback period and a savings-to-investment ratio of 3.87. Annual fuel savings are estimated at 23,723 Million BTU per year.

CURRENT SITUATION: Selected existing direct buried and concrete trench steam supply and condensate return piping is in a deteriorated state. Much of this piping is over twenty years old and is corroded and/or leaking. Uninsulated fiber reinforced plastic (FRP) piping used for condensate return from the family housing area is melted in many locations due to exposure to temperatures above 250 degrees F.

Much of the existing insulation is deteriorated and leakage of steam and condensate is prevalent. Repairs to the existing systems are required frequently and are becoming more costly due to the deteriorated state of the systems and the need to excavate to locate the leaks.

IMPACT IF NOT PROVIDED: If this project is not accomplished, annual expenses of about $248,042 for fuel and maintenance will be incurred that could have been avoided. Additionally, the potential of loosing heating service to buildings served will be greatly increased. If this project is not approved, it will have a negative impact on the HWAAD energy program and will impede progress towards compliance with DEPPM 91-2.

ADDITIONAL: This project has been coordinated with the installation security plan, and no security improvements are required. This project incorporates recommendations of the Energy Engineering Analysis Program, Limited Energy Study of Steam Distribution Systems, performed under Contract No. DACA05-92-C-0155.

This installation is not under consideration for realignment or closure.

JOHN G. ZODROW
Lt. Colonel
Commanding

Estimate Date: 1 September 1995	Index: 1975
Estimated Construction Start: 1 September 1996	Index: 2032
Estimated Midpoint of Construction: 1 December 1996	Index: 2048
Estimated Construction Completion: 1 March 1997	Index: 2060

DD FORM 1391C

Detailed Justification

1. GENERAL: The project is a significant part of Hawthorne Army Ammunition Depot's effort to achieve a 20-percent reduction in energy consumption by FY2000 versus FY1985 baseline levels. The project will also assure that heating services are provided to Industrial Area facilities on a continuing basis, supporting mission requirements.

2. ACCOMMODATIONS NOW IN USE: Not applicable.

3. ANALYSIS OF DEFICIENCY: The present condition of steam distribution and condensate collection piping contributes to unnecessary annual energy consumption and maintenance expenses totaling about $248,042 per year. These costs will be avoided with implementation of the proposed project.

4. CONSIDERATION OF ALTERNATIVES: Alternative piping materials and placement methods were considered. The least costly alternatives are recommended for implementation. The recommended retrofits are those selected in the Limited Energy Study of Steam Distribution Systems, September 1995, prepared under Contract No. DACA 05-C-92-0155.

5. CRITERIA FOR PROPOSED CONSTRUCTION: Design and construction will be in accordance with applicable criteria established in:
   a. DOD 4270.1-M
   b. TM 810-5
   c. Architectural and Engineering Instruction, dated 9 December 1991
   d. A-E Guide Instruction for Army Projects, Volume 1, dated January 1990
   e. A-E Guide, CESPK Cost Estimating Guide, Volume 2, dated December 1989
   f. A-E Guide Volume III, Specifications, dated December 1990
   g. Energy Conservation Investment Program (ECIP) Guidance, dated 10 January 1994.
   h. TM 5-785, Engineering Weather Data
   i. MCASES instructions
   j. TM 5-652, Steam / Hot Water and Chilled Water Distribution Systems Operations and Maintenance Manual
   k. CEGS-02695, Preapproved Underground Heat Distribution System
   l. CEGS-02696, Heat Distribution Systems in Concrete Trenches
   m. CEGS-02697, Aboveground Heat Distribution System

6. PROGRAM FOR RELATED FURNISHINGS AND EQUIPMENT: Not applicable.

7. DISPOSAL OF PRESENT ASSETS: Not applicable.

8. SURVIVAL MEASURES: Not applicable.

9. SUMMARY OF ENVIRONMENTAL CONSEQUENCES: Atmospheric emissions will be reduced as less fuel will be used due to this project. Temporary conditions will exist during the construction period consisting primarily of fugitive dust emissions.

10. EVALUATION OF FLOOD HAZARDS AND ENCROACHMENT ON WETLANDS: Not applicable

11. ECONOMIC JUSTIFICATION: In accordance with ECIP Guidance dated 10 December 1994, an economic analysis has been prepared. Life-cycle cost analysis results are summarized as follows:

• Estimated Construction Cost (including SIOH and design costs)	$851,618
• Annual Energy Savings	23,723 MBTU (4,167,500 MJ)
• First Year Energy Cost Savings	$145,423
• First Year Non-energy Cost Savings	$102,620
• Total First Year Cost Savings	$248,042
• Discounted Energy Savings	$2,069,366
• Discounted Non-energy savings	$1,225,277
• Total Net Discounted Savings	$3,294,643
• Savings-to-Investment Ratio	3.87
• Simple Payback Period	3.43 years

Refer to "Detailed Calculations" for backup data.

12. UTILITY AND TELECOMMUNICATIONS SUPPORT: Not applicable.

13. PROTECTION OF HISTORIC PLACES AND ARCHEOLOGICAL SITES: Review procedures have been implemented for this project in accordance with 36 CFR 800. The review has established that there will be no effect.

14. PROJECT DEVELOPMENT BROCHURE: A Project Development Brochure (PDB-1) dated September 1995 has been prepared.

15. ENERGY REQUIREMENTS: Not applicable.

16. PROVISION FOR THE HANDICAPPED: Not applicable.

17. REAL PROPERTY MAINTENANCE ACTIVITY ANALYSIS: Not applicable.

18. COMMERCIAL ACTIVITIES: This project involves replacement or modification of existing systems for energy conservation. Under these conditions, the provisions of AR 5-XX do not apply, and a "new start or expansion" is not required.

Life Cycle Cost Analysis Summary - Industrial Area
Energy Conservation Investment Program (ECIP)

Location: Hawthorne Army Ammunition Depot Region No. 4 Project No. 40667
Project Title: ECIP Modernize Industrial Area Steam Distribution Fiscal Year FY97
Discrete Portion: Total Project Preparer: KELLER & GANNON
Analysis Date September 1995 Economic Life: 15 Years

1. Investment Costs

A. Construction Costs		$763,099		
B. SIOH	5.6%	$42,734		
C. Design Cost	6.0%	$45,786		
D. Total Cost (1A+1B+1C)		$851,618		
E. Salvage Value of Existing Equipment			$0	
F. Public Utility Company Rebate			$0	
G. Total Investment (1D-1E-1F)				$851,618

2. Energy Savings (+)/Cost(-):

Date of NISTIR 85-3273 Used for Discount Factors: October 1994

Energy Source	Cost $/MBTU	Saving MBTU/Yr(2)		Annual $ Savings(3)	Discount Factor(4)	Discounted Savings(5)
A. Elec.	$12.82	0		$0	12.02	$0
B. Dist	$6.13	23,723		$145,423	14.23	$2,069,366
C. LPG						
D. Other						
E. Demand Savings		0.0	kW	$0	11.30	$0
F. Total		23,723		$145,423		$2,069,366

3. Non Energy Savings (+) or Cost (-):

A. Annual Recurring (+/-)	$102,620	
(1) Discount Factor (Table A)		11.94
(2) Discounted Savings/Cost (3A x 3A1)		$1,225,277

B. Non Recurring Savings (+) or Cost (-)

Item	Savings(+) Cost(-)(1)	Year of Occur. (2)	Discount Factor(3)	Discounted Savings(+)Cost(-)(4)
a.				
b.				
c.				
d. Total				

C Total Non Energy Discounted Savings (3A2+3Bd4)	$1,225,277	
4. First Year DollarSavings (2F3+3A+(3Bd1/Economic Life)):	$248,042	
5. Simple Payback (1G/4):	3.43	Years
6. Total Net Discounted Savings (2F5+3C):	$3,294,643	
7. Savings to Investment Ratio (SIR) (6/1G):	3.87	

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DD Form 1391 Detailed Calculations

Comparison of Replacement Piping Alternatives

A typical pipe section is evaluated for each area. The Industrial Area is, nowadays, more of an administrative and maintenance yard area. Both assume the use of mineral fiber insulation. All but a few sections of pipe are underground. Existing installations include direct buried pipe, pipe in concrete trenches and some conduit encased direct buried piping. Only underground replacement piping is considered.

Alternatives consider both prefabricated piping systems and built-up piping systems. The costs summarized below are intended exclusively for comparing one type of system against another. Some cost elements that affect all alternatives equally are not considered.

A common pipe run in the Industrial Area, and the pipe sizes used to evaluate alternatives, consists of a 4-inch diameter steam pipe and a 3-inch diameter condensate return pipe. Direct burial of single and double pipe conduit are considered. Replacement of pipes in concrete trenches with conduit systems and with built-up piping is considered. Unlike the alternatives shown for the Ordnance Area, the pipes in the Industrial Area do not include allowances for thermal expansion loops; expansion will be accomodated in expansion joints. Cost estimates for comparison pipe segments follow.

Direct Bury Alternatives		**Comparison First Cost $/LF**
Alternative DB1:	14-inch Conduit containing 4-inch Schedule 40 Steam Pipe with 2-inch Insulation and 3-inch Schedule 80 Condensate Pipe with 1-Inch Insulation Direct Bury	$104.95
Alternative DB2:	10-3/4-inch Conduit containing 4-inch Schedule 40 Steam Pipe with 2-inch Insulation **&** 6-inch Conduit with 3-inch FRP Condensate Pipe with 1-Inch Insulation Direct Bury	$135.29
Alternative DB3:	10-3/4-inch Conduit containing 4-inch Schedule 40 Steam Pipe with 2-inch Insulation **&** 8-5/8-inch Conduit with 3-inch Schedule 80 Cond Pipe with 1-Inch Insulation Direct Bury	$125.87

Replace Pipes in Existing Concrete Trench Alternatives		**Comparison First Cost $/LF**
Alternative CT1:	14-inch Conduit containing 4-inch Schedule 40 Steam Pipe with 2-inch Insulation and 3-inch Schedule 80 Condensate Pipe with 1-Inch Insulation Conc Trench	$102.10
Alternative CT2:	10-3/4-inch Conduit containing 4-inch Schedule 40 Steam Pipe with 2-inch Insulation **&** 6-inch Conduit with 3-inch FRP Condensate Pipe with 1-Inch Insulation Conc Trench	$130.90
Alternative CT3:	10-3/4-inch Conduit containing 4-inch Schedule 40 Steam Pipe with 2-inch Insulation **&** 8-5/8-inch Conduit with 3-inch Schedule 80 Cond Pipe with 1-Inch Insulation Conc Trench	$123.02
Alternative CT4:	4-inch Schedule 40 Steam Pipe with 2-inch Insulation and Aluminum Jacket **&** 3-inch Schedule 80 Condensate Pipe with 1-Inch Insulation & Aluminum Jacket	$70.57

Comparison of Replacement Piping Alternatives

Comparison of Repair Costs

Repairs are more difficult, and costly, for two-pipe conduit systems and for buried pipe systems. Repairs for conduit systems require that the conduit be opened up and the leaking section replaced. For two-pipe conduit systems, both pipes are replaced when one is found leaking. Repair costs are similar to original installation costs. Repairs to single pipe conduit systems are less costly, but still involve cutting through and repairing both the service pipe and the conduit. Repairs to piping in concrete trenches do not incur the expense of re-excavating, nor is there the same level of danger of accidentally digging into the pipe. Repairs to above ground piping systems are the least expensive.

Maintenance costs are higher for systems which contain FRP piping because thermal protective devices installed on all condensate entries must be maintained and defective parts replaced. The installed cost per LF of these protective devices is expensed twice during the life of the piping to represent additional maintenance and repairs required for these systems. Results are indicated below.

For purposes of comparison, frequencies of repair during a pipe segment's lifetime are considered. Results are shown below.

Recommended Replacement Piping Configurations

Descriptions of Alternatives	$/LF	Repairs/ Life	Added Maint	Overall Cost/LF	
Direct Bury Alternatives					
Alternative DB1	$104.95	1	$0.00	$209.91	
Alternative DB2	$135.29	0.75	$70.26	$307.02	
Alternative DB3	$125.87	0.5	$0.00	$188.80	←
Replace Pipes in Existing Concrete Trench Alternatives					
Alternative CT1	$102.10	1	$0.00	$204.20	
Alternative CT2	$130.90	0.75	$70.26	$299.33	
Alternative CT3	$123.02	0.5	$0.00	$184.53	
Alternative CT4	$70.57	0.25	$0.00	$88.22	←

Table 1
Summary of Piping Replacement Costs
Industrial Area Steam Distribution

	Recommended		
Alternative Description	**$/LF**	**Total LF**	**Cost $**
Replace Pipes MH A5 to MH A9	$85.23	1,940	$165,343
Rerouting for Buildings 3, 35 & 36	$119.83	1,316	$157,696
Steam Piping - U Street East	$86.12	1,835	$158,033
Family Housing Condensate Pipes	$78.36	3,599	$282,027
Total of Industrial Area Alternatives	**$94.54**	**8,690**	**$763,099**
SIOH 5.6%			$42,734
Design 6.0%			$45,786
Total Request	**$105.50**	**8,690**	**$851,618**

Refer to Figure 1 for locations of piping replacements

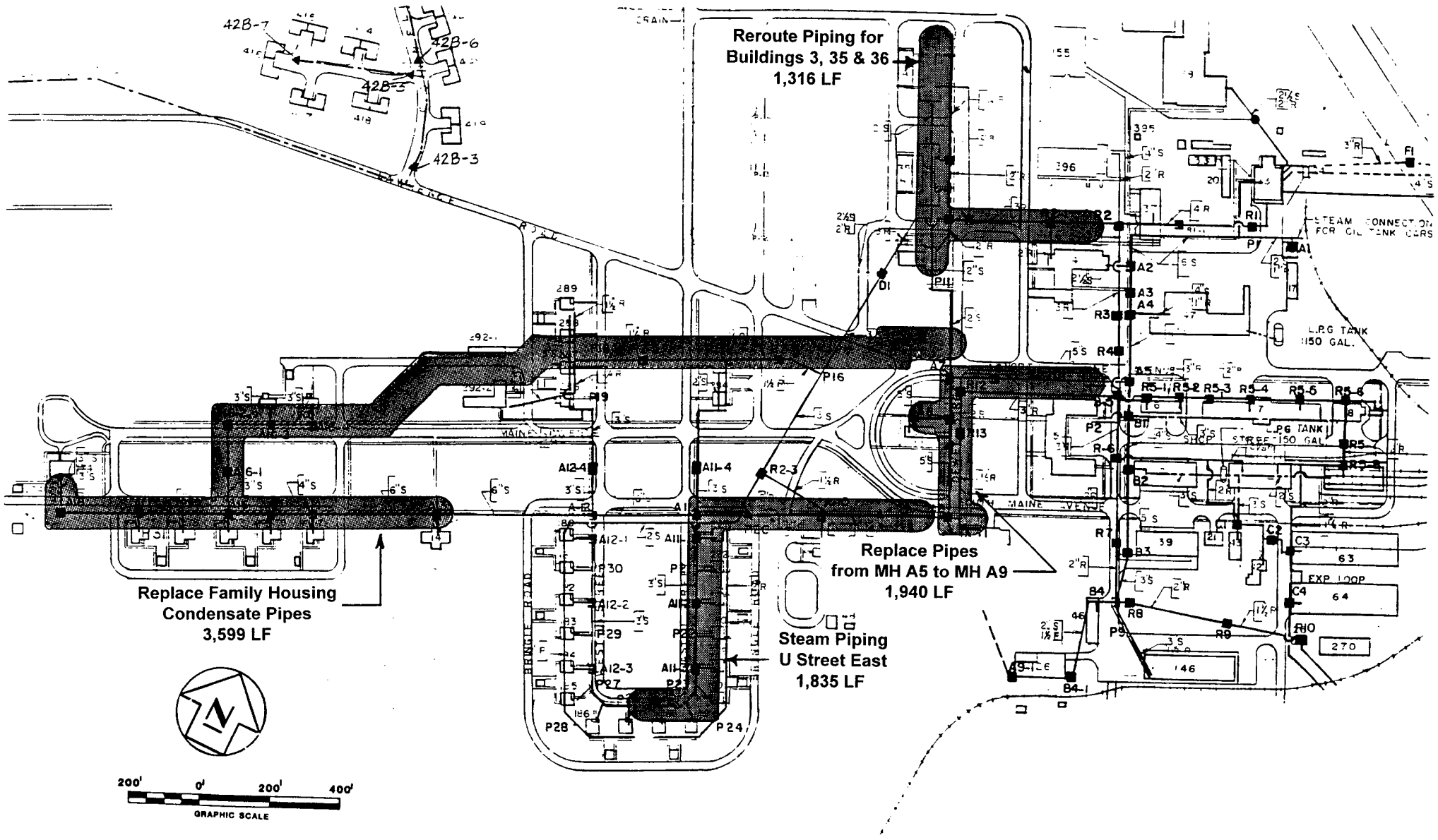

Figure 1
Recommended Steam Distribution System Piping Replacements

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Annual Energy and Maintenance Cost Savings Calculations
Hawthorne Army Ammunition Depot - Industrial Area

Replacing existing deteriorated piping will save both energy and maintenance costs. Energry savings result from reducing leakage from steam and condensate pipes and from reduced conduction/convection losses due to the installation of replacement piping with proper insulation.

Energy Savings Calculations

Boiler Plant Name Plate Data

Boiler Building 13 - Industrial Area

Boilers: 3 Each Fire Tube Boilers Operating Pressure: 105 psig, at 341 °F

h_f = 312 BTU/LB h_{fg} = 877.9 BTU/Lb

Manufacturer: Nebraska Company, Inc.

Serial Nos.:	2D1637	2D1638	2D1639
National Board Nos.:	1599	1600	1601
Maximum AWP (psig):	250	250	250
Boiler Heating Surface:	2,007 SF	2,007 SF	2,007 SF
Year Built:	1974	1974	1974
Rated Steam Capacity:	18 KLB/HR	18 KLB/HR	18 KLB/HR
Boiler Fuel:	No. 2 Diesel Fuel Oil (High Sulfur)		

Boiler Feed Pumps: 2 Each, Myers Centrifugal, 15 HP each, 1-1/2-inch inlets

Boiler Efficiency Tests:

Boiler No.	Oxygen %	Temp °F	Eff %	Condition
13-1	8.8%	290	86.0%	Boiler Cold
13-1	5.1%	440	82.9%	High Fire
13-2	1.0%	310	88.3%	Boiler Cold
13-2	9.1%	-	84.2%	High Fire
13-3	3.6%	350	86.6%	Boiler Cold
13-3	4.6%	360	82.7%	High Fire

For plant efficiency calculations, the high firing efficiency is used since it more closely follows actual operations.

Boiler Plant Efficiency Calculations

	Steam Plant Bldg 13	
Firing (Combustion) Efficiency Test	83.2%	Weighted average of efficiencies
Auxiliary Equipment Uses	-2.0%	allowance for steam ejectors
Radiation Losses @ Figure D-1	-2.0%	
Blowdown Losses (Continuous BD)	-1.5%	
Leaks (Minimal at boiler houses)	-1.0%	Not including distribution leakage
Conduction/Convection	-2.5%	
(Plant only, not including distribution piping; systems rated in "poor" condition due only to age, well maintained.)		
Shut-Down/Cycling Losses	-4.0%	Boilers oversized for current load.
General Equipment Condition	-3.0%	
(Plant only systems rated in "poor" condition due only to age, well maintained.)		
Overall Plant Efficiencies	**67.2%**	

Steam Leakage and Condensate Energy Loss Calculations

Makeup water records are summarized for each of the boiler system. Steam production data is not available.

	Steam Plant Bldg 13
Most recent calendar year May '94 through April '95:	3,429,870 Gallons
Calendar Year 1994:	3,090,330 Gallons

The most recent calendar year data is used in steam and condensate energy loss calculations.

These losses include both steam and condensate leaks. Steam leakage represents a much greater energy loss than does the leakage of condensate. This is illustrated below:

Energy needed to raise makeup water from 50°F (raw water temperature) to 200°F, the condensate return temperature: 150.0 BTU per pound water

Energy needed to raise the 200°F condensate to 341°F, the saturation temperature of 105 psig steam: 144.4 BTU per pound water

Energy needed to vaporize 341°F water at 105 psig (heat of evaporation): 877.9 BTU per pound water

Thus, a steam leak includes loss of the useful work the steam can perform (heat of evaporation) and the energy required to heat makeup water to the vaporization temperature, all three of the above elements, or 1,172.2 BTU per pound water

A condensate leak includes only the energy needed to raise raw makeup water to the condensate return temperature, or 150.0 BTU per pound water

The following calculation shows the percent of total steam plant fuel consumption represented by steam and condensate losses where total losses are attributed exclusively to either steam or condensate.

	Steam Plant Bldg 13	
Energy Losses	**KK BTU/Yr**	**% Total Fuel**
If Leakage is 100% Steam:	33,572	55.4%
If Leakage is 100% Condensate:	8,430	13.9%

Assumes water temp of 50 °F, h_l = 18.1 BTU/LB ; Fuel Oil at 138,700 BTU/Gallon

Based on field observations, it appears that most of the makeup water loss is composed of condensate that is not returned to the central plant. There are only a few steam leaks. Conservatively, then, assume 10% of the losses in the Industrial Area are from condensate. Blowdown is included in makeup water requirements and constitutes about 2% of the total steam flow. This use is subtracted from the loss calculations below. The annual energy savings from repairs to the distribution systems are:

	Industrial Area Steam Plant Bldg 13
Energy Losses	**KK BTU/Yr**
Loss from Steam Leakage	3,357
Loss from Condensate Leakage	7,587
Thermal Losses	10,944
Boiler Plant Efficiency	67.2%
Makeup Water Fuel Uses	16,290
Blowdown Loss (2% of fuel input)	1,213
Leakage Fuel Losses (No 2 Fuel Oil)	**15,077**

Significant additional losses occur from poorly insulated steam and condensate lines. Leakage of steam and condensate has wetted the insulation (if present) to such an extent that little insulating value remains.

Energy Savings from Piping Insulation Losses

Existing piping is deteriorated and leaks have destroyed the value of insulation installed on existing piping. Insulation thermal losses are determined for existing and proposed future piping systems. Detailed calculations follow. Results are summarized here:

Energy Savings	**Industrial Area Steam Plant Bldg 13 KK BTU/Yr**
Load Saved (Heating Season Only)	5,809
Boiler Plant Efficiency	67.2%
Insulation Savings (No 2 Fuel Oil)	**8,646**
Total Fuel Oil Savings	**23,723**

Operation and Maintenance Cost Savings

The proposed new piping systems will reduce operation and maintenance costs significantly. Cost savings for each area are determined below.

Industrial area steam leaks and condensate piping breaks create a chronic problem for the maintenance staff. Service calls to repair the distribution system seem to be a daily occurrence. The proposed repairs will replace most of the fiber reinforced plastic (FRP) piping used for condensate return from the housing area. Repairs have been frequent because the piping is damaged every time steam bypasses a trap and enters the FRP piping inadvertently. The piping is not rated for service above 250°F. One incedent of 100 psig steam entering FRP condensate piping exposes the material to a temperature of at least 340°F.

Other repairs proposed will consolidate steam and condensate piping into the shallow concrete trench system. Repairs to the condensate piping, currently direct buried, will be made more accessible (and less expensive).

Overall, the piping replacements in the Industrial Area are expected to save about 3/4 of present maintenance costs according to maintenance supervisors. During the last year for which records are available, about 3,700 hours per year were spent on preventive maintenance, service calls and on major repairs. Based on a steamfitter rate of $42.33 per Hour and helper rate of $31.63 (Means Steamfitter & Helper, location adjusted) and 3/4 of the total maintenance hours, savings are expected to total:

3,700 hours year x 3/4 x $36.98 per hour = $102,620 per year, including overhead.

Thermal Loss Calculations for New and Deteriorated Existing Steam Distribution & Condensate Piping

Piping Systems

Source: Siddiqui, M.K., Calculations for Insulated Piping Systems, Heating/Piping/Air Conditioning, November 1994

Piping Layout (1=AG; 2=UG):	1 for above ground installation
Outer Pipe Diameter (Inches):	See Table below for actual sizes
Service Temperature:	HP Steam 338°F, LP Steam 250°F, Condensate 200°F
Insulation Conductivity at TM1 (BTUH-IN/SF-°F):	0.31 at 200°F
Insulation Conductivity at TM2 (BTUH-IN/SF-°F):	0.36 at 300°F
Pipe Orientation (1=Horizontal; 2=Vertical):	Normally Horizontal
Ambient Air Temperature (°F):	Average Winter Temperature = 23.4°F from TM 5-785 Bin Data for temps below 72°F (winter)
Wind Speed (MPH):	3.3 from TM 5-785 Bin Data
Surface Emittance:	0.20 for oxidized aluminum jacket (Owens Corning advice)
Average Annual Soil Temperature:	40.0°F from 1989 HVAC Handbook (ASHRAE)
Thermal Conductivity of Soil (BTUH-In/SF-°F):	12.0 assumed based on Table 6, 22.13 1993 ASHRAE Fundamentals Handbook
Burial Depth to Centerline of Pipe (FT):	4.0 FT
Insulation Thickness (Inches):	See below, based on CEGS's for above ground, trench systems and conduit systems.
Air Space (Inches):	See below for various pipe sizes
Inner Diameter of Pipe (Inches):	See below for pipe size and service
Thermal Conductivity for Direct Burried Pipe (BTU-In/(Hr-SF-°F):	Red Brass = 2,784 FRP = 2.30

Nominal Pipe Size	**1**	**1.25**	**1.5**	**2**	**2.5**	**3**	**4**	**5**	**6**	**8**
Pipe Diameter Schedule 40 for Steam Service										
Pipe OD (Inches)	1.182	1.52	1.755	2.221	2.672	3.284	4.263	5.305	6.345	8.303
Pipe ID (Inches)	1.049	1.38	1.61	2.067	2.469	3.068	4.026	5.047	6.065	7.981
Insulation Thickness (Mineral Wool)										
Above Ground (Inches)	2.5	2.5	2.5	3.5	3.5	4.0	4.0	4.0	4.5	4.5
Pipe Trench (Inches)	2.0	2.0	2.5	2.5	2.5	3.0	3.0	3.0	3.5	3.5
UG Conduit (Inches)	2.0	2.0	2.0	2.5	2.5	3.0	3.0	3.0	3.5	3.5
Conduit Casing (Inch)	6.625	6.625	6.625	8.625	8.625	10.750	12.750	12.750	16.000	18.0
Air Space (Inches)	0.813	0.688	0.563	0.813	0.563	0.875	1.375	0.875	1.500	1.500
Pipe Diameter Schedule 80 for Condensate Service										
Pipe OD (Inches)	1.136	1.469	1.7	2.157	2.599	3.2	4.163	5.188	6.193	8.125
Pipe ID (Inches)	0.957	1.278	1.5	1.939	2.323	2.9	3.826	4.813	5.761	7.625
Insulation Thickness (Mineral Wool)										
Above Ground (Inches)	2.0	2.0	2.0	2.0	2.0	2.5	2.5	-	-	-
Pipe Trench (Inches)	1.5	1.5	1.5	1.5	1.5	2.0	2.0	-	-	-
UG Conduit (Inches)	1.5	1.5	1.5	1.5	1.5	2.0	2.0	-	-	-
Conduit Casing (Inch)	6.625	6.625	6.625	8.625	8.625	10.750	10.750	-	-	-
Air Space (Inches)	1.313	1.188	1.063	1.813	1.563	1.875	1.375	-	-	-

Thermal Loss Calculations for New and Deteriorated Existing Steam Distribution & Condensate Piping

Nominal Pipe Size	1	1.25	1.5	2	2.5	3	4	5	6	8	2 LPS		2.5 LPS				
Nominal Size Sch 40 for Steam Service, New Piping																	
Above Ground (BTUH/LF)	34.6	39.2	42.3	40.4	44.6	46.6	54.3	62.3	65.0	78.0	-	-	-	-	-	-	-
Pipe Trench (BTUH/LF)	37.6	42.9	41.5	47.3	52.7	53.9	63.5	73.5	75.3	91.2	34	-	37.9	-	-	-	-
UG Conduit (BTUH/LF)	34.8	37.5	42.5	43.3	48.0	49.2	57.7	66.1	67.9	81.6	-	-	-	-	-	-	-
Nominal Size Sch 80 for Condensate Service, New Piping																	
Above Ground (BTUH/LF)	18.9	23.9	25.9	29.8	33.4	33.4	39.7	-	-	-	-	-	-	-	-	-	-
Pipe Trench (BTUH/LF)	23.3	26.9	29.3	33.9	38.3	37.2	44.5	-	-	-	-	-	-	-	-	-	-
UG Conduit (BTUH/LF)	20.9	24.0	26.0	30.1	33.7	32.7	38.7	-	-	-							
Nominal Size Sch 40 for Steam Service, Existing, Deteriorated Piping											**2 LPS**		**2.5 LPS**				
Above Ground (BTUH/LF)	81.8	98.2	109.5	131.7	152.9	181.5	226.9	274.8	322.3	411.1	-	-	-	-	-	-	-
Pipe Trench (BTUH/LF)	75.6	90.5	100.8	120.9	140.1	166.0	207.0	250.5	293.5	374.0	86.6	-	100.4	-	-	-	-
UG Conduit (BTUH/LF)	67.2	79.2	86.9	102.5	115.8	134.7	163.8	189.0	217.7	263.4	-	-	-	-	-	-	-
Nominal Size Sch 80 for Condensate Service, Existing, Deteriorated Piping																**Buried Bare Pipe**	
Above Ground (BTUH/LF)	43.5	52.3	58.3	70.1	81.4	96.6	120.8	-	-	-	**1.5**	**1.5**	**2**	**2**	**3**	**3**	**4**
Pipe Trench (BTUH/LF)	39.9	47.8	53.2	63.8	73.9	87.5	109.2	-	-	-	FRP	Brass	FRP	Brass	FRP	FRP	Brass
UG Conduit (BTUH/LF)	90.3	106.5	116.1	139.8	154.0	175.8	197.0	-	-	-	201.4	232.2	221.6	244.9	251.0	270.4	290.0

Thermal Savings for Industrial Area Steam Distribution System Piping Replacements

Location	Service	Existing Placement	Proposed Placement	Surface	Quantity		Current	Proposed	Thermal Savings	
					No. Units	Unit Meas.	BTUH/LF	BTUH/LF	Heat Load Saved BTUH	KK BTU/Yr Saved
Pipe Replacement Bldg 13 to MH B4 (Alternative 1)										
MH B1 to Bldg 6	2" (40) HPS	Conc Trench	Conc Trench	Conc Trench	LF	32	120.9	47.3	2,355	10
MH B2 to MH B3	2" (80) Cond	DB Red Brass	Conc Trench	Conc Trench	LF	198	244.9	33.9	41,778	183
MH B2 to MH B3	2" (80) Cond	DB Red Brass	Conc Trench	Conc Road	LF	25	244.9	33.9	5,275	23
MH B3 to MH B4	2" (80) Cond	DB Red Brass	DB Conduit	Asphalt	LF	75	244.9	30.1	16,110	71
MH B3 to MH B4	2" (80) Cond	DB Red Brass	DB Conduit	Conc Road	LF	22	244.9	30.1	4,726	21
MH B3 to MH B4	3" (40) HPS	Direct Bury	DB Conduit	Asphalt	LF	75	492.7	49.2	33,263	146
MH B3 to MH B4	3" (40) HPS	Direct Bury	DB Conduit	Conc Road	LF	22	492.7	49.2	9,757	43
MH A2-1 to MH A5	3" (80) Cond	DB Red Brass	Conc Trench	Lawn	LF	349	270.4	37.2	81,387	356
MH A5 to MH B1	3" (80) Cond	DB Red Brass	Conc Trench	Conc Trench	LF	44	270.4	37.2	10,261	45
MH B1 to MH B2	3" (80) Cond	DB Red Brass	Conc Trench	Conc Trench	LF	102	270.4	37.2	23,786	104
MH B1 to MH B2	3" (80) Cond	DB Red Brass	Conc Trench	Conc Road	LF	25	270.4	37.2	5,830	26
MH B1 to MH B2	4" (40) HPS	Conc Trench	Conc Trench	Conc Trench	LF	102	207.0	63.5	14,637	64
MH B1 to MH B2	4" (40) HPS	Conc Trench	Conc Trench	Conc Road	LF	25	207.0	63.5	3,588	16
Bldg 13 to MH A2-1	4" (80) Cond	Conc Trench	Conc Trench	Lawn	LF	330	109.2	63.5	15,081	66
MH A5 to MH B1	5" (40) HPS	Conc Trench	Conc Trench	Conc Trench	LF	44	250.5	73.5	7,788	34
MH B2 to MH B3	5" (40) HPS	Conc Trench	Conc Trench	Conc Trench	LF	198	250.5	73.5	35,046	154
MH B2 to MH B3	5" (40) HPS	Conc Trench	Conc Trench	Conc Road	LF	25	250.5	73.5	4,425	19
Bldg 13 to MH A5	6" (40) HPS	Conc Trench	Conc Trench	Lawn	LF	679	293.5	75.3	148,158	649
Bldg 13 to MH A5	6" (40) HPS	Conc Trench	Conc Trench	Conc Road	LF	38	293.5	75.3	8,292	36
Pipe Replacement MH A7 to MH A9 (Alternative 2)										
MH A7 to MH A9	5" (40) HPS	Conc Trench	Conc Trench	Conc Trench	LF	298	250.5	73.5	52,746	231
MH A7 to MH A9	5" (40) HPS	Conc Trench	Conc Trench	Conc Road	LF	22	250.5	73.5	3,894	17
MH A7 to MH A9	3" (80) Cond	DB Red Brass	Conc Trench	Conc Trench	LF	298	270.4	37.2	69,494	304
MH A7 to MH A9	3" (80) Cond	DB Red Brass	Conc Trench	Conc Road	LF	22	270.4	37.2	5,130	22
MH A9 to Bldg 1	2 1/2" (40) HPS	Conc Trench	Conc Trench	Conc Trench	LF	100	140.1	52.7	8,740	38
MH A9 to Bldg1	1 1/2" (80) Cond	Conc Trench	Conc Trench	Conc Trench	LF	140	53.2	29.3	3,346	15
MH A8 to Bldg 2	2" (40) HPS	Conc Trench	Conc Trench	Conc Trench	LF	130	120.9	47.3	9,568	42
MH A8 to Bldg 2	1 1/2" (80) Cond	Conc Trench	Conc Trench	Conc Trench	LF	130	53.2	29.3	3,107	14
MH A5 to MH A7	5" (40) HPS	Conc Trench	Conc Trench	Conc Trench	LF	349	250.5	73.5	61,773	271
MH A5 to MH A7	5" (40) HPS	Conc Trench	Conc Trench	Conc Road	LF	51	250.5	73.5	9,027	40
MH A5 to MH A7	3" (80) Cond	DB Red Brass	Conc Trench	Conc Trench	LF	349	270.4	37.2	81,387	356
MH A5 to MH A7	3" (80) Cond	DB Red Brass	Conc Trench	Conc Road	LF	51	270.4	37.2	11,893	52

Thermal Savings for Industrial Area Steam Distribution System Piping Replacements

Location	Service	Existing Placement	Proposed Placement	Surface	Quantity		Current BTUH/LF	Proposed BTUH/LF	Thermal Savings	
					No. Units	Unit Meas.			Heat Load Saved BTUH	KK BTU/Yr Saved
Pipe Rerouting for Bldgs 3, 35 & 36 (Alternative 3)										
Bldg 3 to Bldg 35	2" (40) HPS	Direct Bury	DB Conduit	Lawn	LF	71	120.9	43.3	5,510	24
Bldg 3 to Bldg 35	2" (40) HPS	Direct Bury	DB Conduit	Conc Road	LF	18	120.9	43.3	1,397	6
Bldg 3 to Bldg 35	2" (40) HPS	Direct Bury	DB Conduit	Sidewalk	LF	5	120.9	43.3	388	2
Bldg 3 to Bldg 35	2" (80) Cond	DB Red Brass	DB Conduit	Lawn	LF	71	244.9	30.1	15,251	67
Bldg 3 to Bldg 35	2" (80) Cond	DB Red Brass	DB Conduit	Conc Road	LF	18	244.9	30.1	3,866	17
Bldg 3 to Bldg 35	2" (80) Cond	DB Red Brass	DB Conduit	Sidewalk	LF	5	244.9	30.1	1,074	5
MH A2-1 to MH A2-2	2" (40) HPS	Rerouted Pipe	DB Conduit	Asphalt	LF	185	0.0	43.3	(8,011)	(35)
MH A2-2 to MH A2-3	2" (40) HPS	Rerouted Pipe	DB Conduit	Asphalt	LF	241	0.0	43.3	(10,435)	(46)
MH A2-2 to MH A2-3	2" (40) HPS	Rerouted Pipe	DB Conduit	Conc Road	LF	42	0.0	43.3	(1,819)	(8)
MH A2-1 to MH A2-2	4" (80) Cond	DB Red Brass	DB Conduit	Asphalt	LF	185	290	38.7	46,491	204
MH A2-2 to MH A2-3	3" (80) Cond	DB Red Brass	DB Conduit	Asphalt	LF	241	270.4	32.7	57,286	251
MH A2-2 to MH A2-3	3" (80) Cond	DB Red Brass	DB Conduit	Conc Road	LF	42	270.4	32.7	9,983	44
Bldg 35 to Bldg 36	2" (40) HPS	Direct Bury	DB Conduit	Conc Road	LF	20	120.9	43.3	1,552	7
Bldg 35 to Bldg 36	2" (80) Cond	DB Red Brass	DB Conduit	Conc Road	LF	20	244.9	30.1	4,296	19
Bldg 35 to Bldg 36	2" (40) HPS	Direct Bury	DB Conduit	Lawn	LF	76	120.9	43.3	5,898	26
Bldg 35 to Bldg 36	2" (80) Cond	DB Red Brass	DB Conduit	Lawn	LF	76	244.9	30.1	16,325	72
Rerouted Existing	2" (40) HPS	Conc Trench	rerouted, see above		LF	267	120.9	0	32,280	141
Steam Pipe Replacements for U Street - East (Alternative 4)										
MH A9 to MH EJ3	2 1/2" (80) Cond	Rerouted Pipe	Conc Trench	Conc Trench	LF	140	0	38.3	(5,362)	(23)
MH A10 to Bldg 42	2" (40) HPS	Conc Trench	Conc Trench	Conc Trench	LF	75	120.9	47.3	5,520	24
MH A10 to Bldg 42	2" (80) Cond	Conc Trench	Conc Trench	Conc Trench	LF	75	63.8	33.9	2,243	10
MH A10 to MH A11	4" (40) HPS	Conc Trench	Conc Trench	Conc Trench	LF	300	207.0	63.5	43,050	189
MH A10 to MH A11	2 1/2" (80) Cond	Rerouted Pipe	Conc Trench	Conc Trench	LF	300	0	38.3	(11,490)	(50)
MH A11 to MH A11J	2 1/2" (80) Cond	Rerouted Pipe	Conc Trench	Conc Trench	LF	20	0	38.3	(766)	(3)
MH A11 to A11-3	2 1/2" (40) LPS	Conc Trench	Conc Trench	Conc Trench	LF	350	100.4	37.9	21,875	96
MH A11-3 to P26	2 1/2" (40) LPS	Conc Trench	Conc Trench	Conc Trench	LF	150	100.4	37.9	9,375	41
MH A11-1 to V	2" (40) LPS	Conc Trench	Conc Trench	Conc Trench	LF	40	86.6	34	2,104	9
MHr P21 to U	2" (40) LPS	Conc Trench	Conc Trench	Conc Trench	LF	40	86.6	34	2,104	9
MH A11-2 to T	2" (40) LPS	Conc Trench	Conc Trench	Conc Trench	LF	40	86.6	34	2,104	9
MH P22 To S	2 1/2" (40) LPS	Conc Trench	Conc Trench	Conc Trench	LF	40	100.4	37.9	2,500	11
MH A11-3 to R	2 1/2" (40) LPS	Conc Trench	Conc Trench	Conc Trench	LF	40	100.4	37.9	2,500	11
MH P23 to Q	2 1/2" (40) LPS	Conc Trench	Conc Trench	Conc Trench	LF	50	100.4	37.9	3,125	14

Thermal Savings for Industrial Area Steam Distribution System Piping Replacements

Location	Service	Existing Placement	Proposed Placement	Surface	Quantity		Current BTUH/LF	Proposed BTUH/LF	Thermal Savings	
					No. Units	Unit Meas.			Heat Load Saved BTUH	KK BTU/Yr Saved
MH P24 to P	2 1/2" (40) LPS	Conc Trench	Conc Trench	Conc Trench	LF	55	100.4	37.9	3,438	15
MH P25 to O	2 1/2" (40) LPS	Conc Trench	Conc Trench	Conc Trench	LF	40	100.4	37.9	2,500	11
MH P25 to MHP26	2 1/2" (40) LPS	Conc Trench	Conc Trench	Conc Trench	LF	80	100.4	37.9	5,000	22
Existing Red Brass	2" Brass Cond	DB Red Brass	rerouted, see above		LF	195	244.9	0	47,756	209
Condensate Pipe	3" Brass Cond	DB Red Brass	rerouted, see above		LF	908	270.4	0	245,523	1,075
Family Housing Condensate Piping Replacement (Alternative 5)										
MH A13 to MH A14	1" (80) Cond	Conc Trench	Conc Trench	Conc Trench	LF	300	39.9	23.3	4,980	22
MH A13 to MH A14	1" (80) Cond	Conc Trench	Conc Trench	Conc Road	LF	19	39.9	23.3	315	1
MH A14 to MH A15	2" (80) Cond	Conc Trench	Conc Trench	Conc Trench	LF	100	63.8	33.9	2,990	13
MH A15 to MH A14	1 1/2" (80) Cond	Conc Trench	Conc Trench	Conc Trench	LF	100	53.2	29.3	2,390	10
MH A15 to MH A16	2" (80) Cond	Conc Trench	Conc Trench	Conc Trench	LF	95	63.8	33.9	2,841	12
MH A17-1 to A16	1" (80) Cond	Conc Trench	Conc Trench	Conc Trench	LF	95	39.9	23.3	1,577	7
MH A17-1 to A16	1 1/2" (80) Cond	Conc Trench	Conc Trench	Conc Trench	LF	95	53.2	29.3	2,271	10
MH A18 to A17-1	1" (80) Cond	Conc Trench	Conc Trench	Conc Trench	LF	330	39.9	23.3	5,478	24
MH A18 to A17-1	1" (80) Cond	Conc Trench	Conc Trench	Conc Road	LF	20	39.9	23.3	332	1
MH A14 to F/179	1 1/2" (80) Cond	Conc Trench	Conc Trench	Conc Trench	LF	33	53.2	29.3	789	3
MH A15 to E/178	1 1/2" (80) Cond	Conc Trench	Conc Trench	Conc Trench	LF	44	53.2	29.3	1,052	5
MH A16 to D/177	1 1/2" (80) Cond	Conc Trench	Conc Trench	Conc Trench	LF	44	53.2	29.3	1,052	5
MH A17-1 to C/176	1 1/2" (80) Cond	Conc Trench	Conc Trench	Conc Trench	LF	44	53.2	29.3	1,052	5
MH A17 to B/175	1 1/2" (80) Cond	Conc Trench	Conc Trench	Conc Trench	LF	44	53.2	29.3	1,052	5
MH A18 to A/174	2" (80) Cond	Conc Trench	Conc Trench	Conc Trench	LF	65	63.8	33.9	1,944	9
MH A18 to A/174	2" (80) Cond	Conc Trench	Conc Trench	Conc Road	LF	15	63.8	33.9	449	2
MH A16 to N-1	2" (80) Cond	DB FRP Pipe	DB Conduit	Lawn	LF	311	221.6	30.1	59,557	261
MH A16 to N-1	2" (80) Cond	DB FRP Pipe	DB Conduit	Conc Road	LF	40	221.6	30.1	7,660	34
MH A16 to N-1	2" (80) Cond	DB FRP Pipe	DB Conduit	Sidewalk	LF	5	221.6	30.1	958	4
MH N-1 to DD/291	1 1/2" (80) Cond	DB FRP Pipe	DB Conduit	Lawn	LF	35	201.4	26	6,139	27
MH N-1 to N-2	2" (80) Cond	DB FRP Pipe	DB Conduit	Lawn	LF	120	221.6	30.1	22,980	101
MH N-1 to N-2	2" (80) Cond	DB FRP Pipe	DB Conduit	Sidewalk	LF	10	221.6	30.1	1,915	8
MH N-2 to CC/290	1 1/2" (80) Cond	DB FRP Pipe	DB Conduit	Lawn	LF	35	201.4	26	6,139	27
MH N-2 to N-3	2" (80) Cond	DB FRP Pipe	DB Conduit	Lawn	LF	514	221.6	30.1	98,431	431
MH N-2 to N-3	2" (80) Cond	DB FRP Pipe	DB Conduit	Conc Road	LF	20	221.6	30.1	3,830	17
MH N-3 to 292-2	1 1/2" (80) Cond	DB FRP Pipe	DB Conduit	Lawn	LF	40	201.4	26	7,016	31
MH N-3 to N-4	2" (80) Cond	DB FRP Pipe	DB Conduit	Lawn	LF	100	221.6	30.1	19,150	84

Thermal Savings for Industrial Area Steam Distribution System Piping Replacements

Location	Service	Existing Placement	Proposed Placement	Surface	Quantity		Current BTUH/LF	Proposed BTUH/LF	Thermal Savings	
					No. Units	Unit Meas.			Heat Load Saved BTUH	KK BTU/Yr Saved
MH N-3 to N-4	2" (80) Cond	DB FRP Pipe	DB Conduit	Conc Road	LF	20	221.6	30.1	3,830	17
MH N-4 to N-5	2" (80) Cond	DB FRP Pipe	DB Conduit	Lawn	LF	362	221.6	30.1	69,323	304
MH N-4 to N-5	2" (80) Cond	DB FRP Pipe	DB Conduit	Conc Road	LF	40	221.6	30.1	7,660	34
MH N-4 to N-5	2" (80) Cond	DB FRP Pipe	DB Conduit	Sidewalk	LF	10	221.6	30.1	1,915	8
MH N-5 to N-6	2" (80) Cond	DB FRP Pipe	DB Conduit	Lawn	LF	454	221.6	30.1	86,941	381
MH N-5 to N-6	2" (80) Cond	DB FRP Pipe	DB Conduit	Conc Road	LF	40	221.6	30.1	7,660	34
Shop Area Condensate Piping Replacements (Alternative 6)										
MH A-5 to R5-1	3" (80) Cond	DB Red Brass	DB Conduit	Lawn	LF	75	270.4	32.7	17,828	78
MH R5-1 to R5-2	3" (80) Cond	DB Red Brass	DB Conduit	Lawn	LF	105	270.4	32.7	24,959	109
MH R5-1 to R5-2	2" (80) Cond	DB Red Brass	DB Conduit	Sidewalk	LF	5	244.9	30.1	1,074	5
MH R5-1 to Bldg 6	1 1/2" (80) Cond	DB Red Brass	DB Conduit	Lawn	LF	15	232.2	26	3,093	14
MH R5-2 to Bldg 6	1 1/2" (80) Cond	DB Red Brass	DB Conduit	Lawn	LF	15	232.2	26	3,093	14
MH R5-2 to R5-4	2" (80) Cond	DB Red Brass	DB Conduit	Lawn	LF	25	244.9	30.1	5,370	24
MH R5-2 to R5-4	2" (80) Cond	DB Red Brass	DB Conduit	Concrete	LF	138	244.9	30.1	29,642	130
MH R5-4 to Bldg 7	1 1/2" (80) Cond	DB Red Brass	DB Conduit	Lawn	LF	15	232.2	26	3,093	14
Bldg 6 to Bldg 7	3" (80) Cond	DB Red Brass	DB Conduit	Lawn	LF	20	270.4	32.7	4,754	21
Bldg 6 to Bldg 7	3" (80) Cond	DB Red Brass	DB Conduit	Concrete	LF	25	270.4	32.7	5,943	26
Bldg 7 to Bldg 8	3" (80) Cond	DB Red Brass	DB Conduit	Lawn	LF	50	270.4	32.7	11,885	52
MH R5-4 to R5-5	2" (80) Cond	DB Red Brass	DB Conduit	Lawn	LF	140	244.9	30.1	30,072	132
MH R5-4 to R5-5	2" (80) Cond	DB Red Brass	DB Conduit	Concrete	LF	2	244.9	30.1	430	2
MH R5-4 to R5-5	2" (80) Cond	DB Red Brass	DB Conduit	Sidewalk	LF	5	244.9	30.1	1,074	5
MH R5-5 to R5-6	2" (80) Cond	DB Red Brass	DB Conduit	Lawn	LF	100	244.9	30.1	21,480	94
MH R5-5 to R5-6	2" (80) Cond	DB Red Brass	DB Conduit	Concrete	LF	30	244.9	30.1	6,444	28
MH R5-6 to R5-8	2" (80) Cond	DB Red Brass	DB Conduit	Lawn	LF	50	244.9	30.1	10,740	47
MH R5-6 to R5-8	2" (80) Cond	DB Red Brass	DB Conduit	Concrete	LF	45	244.9	30.1	9,666	42
MH R5-6 to R5-8	2" (80) Cond	DB Red Brass	DB Conduit	Building	LF	50	244.9	30.1	10,740	47
MH R5-8 to Bldg 11	1 1/2" (80) Cond	DB Red Brass	DB Conduit	Sidewalk	LF	5	232.2	26	1,031	5
MH R5-8 to Bldg 11	1 1/2" (80) Cond	DB Red Brass	DB Conduit	Lawn	LF	7	232.2	26	1,443	6
Total of Recommended Alternatives 2, 3, 4 and 5										**5,809**
Boiler Plant Efficiency										67.2%
Fuel Oil Savings of Piping Thermal Losses (kk BTU/Year)										**8,646**

CONSTRUCTION COST ESTIMATE				Date Prepared Sep - 95		Sheet 1 of 11	
Project ECIP Modernize Industrial Area Steam Distribution				Project No. PN-40667		Basis for Estimate	
Location Hawthorne Army Ammunition Depot, Nevada				Code A (no design completed)			
Engineer-Architect Keller & Gannon							
Drawing No. **Replace Pipes from Manhole A5 to Manhole A9**				Estimator **BIH**		Checked By **RCL**	
Location	Service	Placement	Surface	Quantity No. Units	Quantity Unit Meas.	Unit Cost	Total Cost
Piping cost							
MH A7 to MH A9	5" (40) HPS	Conc Trench	Conc	298	LF	$65.58	$19,543
MH A7 to MH A9	5" (40) HPS	Conc Trench	Conc Road	22	LF	$65.58	$1,443
MH A7 to MH A9	3" (80) Cond	Conc Trench	Conc	298	LF	$37.91	$11,298
MH A7 to MH A9	3" (80) Cond	Conc Trench	Conc Road	22	LF	$37.91	$834
MH A9 to Bldg 1	2 1/2" (40)	Conc Trench	Conc	100	LF	$31.26	$3,126
MH A9 to Bldg1	1 1/2" (80)	Conc Trench	Conc	140	LF	$37.91	$5,308
MH A8 to Bldg 2	2" (40) HPS	Conc Trench	Conc	130	LF	$26.71	$3,472
MH A8 to Bldg 2	1 1/2" (80)	Conc Trench	Conc	130	LF	$20.00	$2,599
MH A5 to MH A7	5" (40) HPS	Conc Trench	Conc	349	LF	$65.58	$22,887
MH A5 to MH A7	5" (40) HPS	Conc Trench	Conc Road	51	LF	$65.58	$3,345
MH A5 to MH A7	3" (80) Cond	Conc Trench	Conc	349	LF	$37.91	$13,232
MH A5 to MH A7	3" (80) Cond	Conc Trench	Conc Road	51	LF	$37.91	$1,934
						Total =	$89,020
Demoliition cost size as in parallel return line.)							
MH A7 to MH A9	5" (40) HPS	Conc Trench	Conc	298	LF	$4.69	$1,398
MH A7 to MH A9	5" (40) HPS	Conc Trench	Conc Road	22	LF	$4.69	$103
MH A7 to MH A9	3" (80) Cond	Conc Trench	Conc	298	LF	$0.00	$0
MH A7 to MH A9	3" (80) Cond	Conc Trench	Conc Road	22	LF	$0.00	$0
MH A9 to Bldg 1	2 1/2" (40)	Conc Trench	Conc	100	LF	$3.18	$318
MH A9 to Bldg1	1 1/2" (80)	Conc Trench	Conc	140	LF	$1.17	$164
MH A8 to Bldg 2	2" (40) HPS	Conc Trench	Conc	130	LF	$1.17	$152
MH A8 to Bldg 2	1 1/2" (80)	Conc Trench	Conc	130	LF	$0.00	$0
MH A5 to MH A7	5" (40) HPS	Conc Trench	Conc	349	LF	$4.69	$1,637
MH A5 to MH A7	5" (40) HPS	Conc Trench	Conc Road	51	LF	$4.69	$239
MH A5 to MH A7	3" (80) Cond	Conc Trench	Conc	349	LF	$0.00	$0
MH A5 to MH A7	3" (80) Cond	Conc Trench	Conc Road	51	LF	$0.00	$0
						Total =	$4,010
Construction cost							
MH A7 to MH A9	5" (40) HPS	Conc Trench	Conc	298	LF	$3.18	$947
MH A7 to MH A9	5" (40) HPS	Conc Trench	Conc Road	22	LF	$17.62	$388
MH A7 to MH A9	3" (80) Cond	Conc Trench	Conc	298	LF	$3.18	$947
MH A7 to MH A9	3" (80) Cond	Conc Trench	Conc Road	22	LF	$17.62	$388
MH A9 to Bldg 1	2 1/2" (40)	Conc Trench	Conc	100	LF	$3.18	$318
MH A9 to Bldg1	1 1/2" (80)	Conc Trench	Conc	140	LF	$3.18	$445
MH A8 to Bldg 2	2" (40) HPS	Conc Trench	Conc	130	LF	$3.18	$413
MH A8 to Bldg 2	1 1/2" (80)	Conc Trench	Conc	130	LF	$3.18	$413
MH A5 to MH A7	5" (40) HPS	Conc Trench	Conc	349	LF	$3.18	$1,109
MH A5 to MH A7	5" (40) HPS	Conc Trench	Conc Road	51	LF	$17.62	$899
MH A5 to MH A7	3" (80) Cond	Conc Trench	Conc	349	LF	$3.18	$1,109
MH A5 to MH A7	3" (80) Cond	Conc Trench	Conc Road	51	LF	$17.62	$899
						Total =	$8,273

CONSTRUCTION COST ESTIMATE				Date Prepared Sep - 95		Sheet 2 of 11	
Project: ECIP Modernize Industrial Area Steam Distribution				Project No. PN-40667		Basis for Estimate	
Location: Hawthorne Army Ammunition Depot, Nevada				Code A (no design completed)			
Engineer-Architect: Keller & Gannon							
Drawing No. **Replace Pipes from Manhole A5 to Manhole A9**				Estimator **BIH**		Checked By **RCL**	
Location	Service	Placement	Surface	Quantity No. Units	Quantity Unit Meas.	Unit Cost	Total Cost
Fittings cost							
MH A7	5" (40) HPS ' T '			2	EA	$416	$832
	5" (40) HPS ' 45° EL '			2	EA	$296	$591
	1 1/2" Drip Trap Ass.			1	EA	$1,999	$1,999
	3" (80) Cond ' T '			2	EA	$341	$682
	3" (80) Cond ' 90° EL '			1	EA	$158	$158
MH A8	5" (40) HPS ' T '			2	EA	$416	$832
	5" (40) HPS ' 45° EL '			2	EA	$296	$591
	1 1/2" Drip Trap Ass.			1	EA	$1,999	$1,999
	2" HPS Valve			1	EA	$282	$282
	3" (80) Cond ' T '			2	EA	$341	$682
	3" (80) Cond ' 90° EL '			1	EA	$158	$158
	2" Cond Valve			1	EA	$282	$282
MH A9	5" (40) HPS ' T '			1	EA	$416	$416
	2 1/2" HPS Valve			1	EA	$858	$858
	3" (80) Cond ' T '			1	EA	$341	$341
	1 1/2" Cond Valve			1	EA	$217	$217
Expansion Joints	5" Steam or Condensate			7	EA	$724	$5,066
	4" Steam or Condensate			1	EA	$575	$575
						Total =	$16,561
Subtotal							**$117,863**
Nevada Sales Tax	3.75%	Based on average of materials costs				54%	$2,386
Subtotal							$120,249
Contractor OH & Profit	25.0%						30,062
Subtotal							$150,312
Estimating Contingency	10.0%						15,031
Total Probable Construction Cost							**$165,343**
Average Cost per Linear Foot Including Steam and Condensate Piping & Fittings							$85.23

CONSTRUCTION COST ESTIMATE				Date Prepared Sep - 95		Sheet 3	of 11
Project ECIP Modernize Industrial AreasSteam Distribution				Project No. PN-40667		Basis for Estimate	
Location Hawthorne Army Ammunition Depot, Nevada				Code A (no design completed)			
Engineer-Architect Keller & Gannon							
Drawing No. **Reroute Pipes for Buildings 3, 35 & 36**				Estimator **BIH**		Checked By **RCL**	
Location	Service	Placement	Surface	Quantity No. Units	Quantity Unit Meas.	Unit Cost	Total Cost
Piping cost							
Bldg 3 to Bldg 35	2" (40) HPS	Direct Bury	Lawn	71	LF	$55.50	$3,940
Bldg 3 to Bldg 35	2" (40) HPS	Direct Bury	Conc Road	18	LF	$55.50	$999
Bldg 3 to Bldg 35	2" (40) HPS	Direct Bury	Sidewalk	5	LF	$55.50	$277
Bldg 3 to Bldg 35	2" (80) Cond	Direct Bury	Lawn	71	LF	$48.67	$3,456
Bldg 3 to Bldg 35	2" (80) Cond	Direct Bury	Conc Road	18	LF	$48.67	$876
Bldg 3 to Bldg 35	2" (80) Cond	Direct Bury	Sidewalk	5	LF	$48.67	$243
MH A2-1 to MH A2-2	2" (40) HPS	Direct Bury	Asphalt	185	LF	$55.50	$10,267
MH A2-2 to MH A2-3	2" (40) HPS	Direct Bury	Asphalt	241	LF	$55.50	$13,374
MH A2-2 to MH A2-3	2" (40) HPS	Direct Bury	Conc Road	42	LF	$55.50	$2,331
MH A2-1 to MH A2-2	4" (80) Cond	Direct Bury	Asphalt	185	LF	$66.75	$12,349
MH A2-2 to MH A2-3	3" (80) Cond	Direct Bury	Asphalt	241	LF	$59.70	$14,388
MH A2-2 to MH A2-3	3" (80) Cond	Direct Bury	Conc Road	42	LF	$59.70	$2,507
Through Bldg 3	2" (80) Cond	0	0	60	LF	$48.67	$2,920
Through Bldg 35	2" (80) Cond	0	0	135	LF	$48.67	$6,570
Bldg 35 to Bldg 36	2" (40) HPS	Direct Bury	Conc Road	20	LF	$55.50	$1,110
Bldg 35 to Bldg 36	2" (80) Cond	Direct Bury	Conc Road	20	LF	$48.67	$973
Bldg 35 to Bldg 36	2" (40) HPS	Direct Bury	Lawn	76	LF	$55.50	$4,218
Bldg 35 to Bldg 36	2" (80) Cond	Direct Bury	Lawn	76	LF	$48.67	$3,699
						Total =	$84,498
Demolition cost Existing piping is to be abandoned in place; demolition cost = $0							
Construction cost							
Bldg 3 to Bldg 35	2" (40) HPS	Direct Bury	Lawn	71	LF	$4.77	$339
Bldg 3 to Bldg 35	2" (40) HPS	Direct Bury	Conc Road	18	LF	$18.02	$324
Bldg 3 to Bldg 35	2" (40) HPS	Direct Bury	Sidewalk	5	LF	$12.87	$64
Bldg 3 to Bldg 35	2" (80) Cond	Direct Bury	Lawn	71	LF	$4.77	$339
Bldg 3 to Bldg 35	2" (80) Cond	Direct Bury	Conc Road	18	LF	$18.02	$324
Bldg 3 to Bldg 35	2" (80) Cond	Direct Bury	Sidewalk	5	LF	$12.87	$64
MH A2-1 to MH A2-2	2" (40) HPS	Direct Bury	Asphalt	185	LF	$12.87	$2,380
MH A2-2 to MH A2-3	2" (40) HPS	Direct Bury	Asphalt	241	LF	$12.87	$3,101
MH A2-2 to MH A2-3	2" (40) HPS	Direct Bury	Conc Road	42	LF	$18.02	$757
MH A2-1 to MH A2-2	4" (80) Cond	Direct Bury	Asphalt	185	LF	$12.87	$2,380
MH A2-2 to MH A2-3	3" (80) Cond	Direct Bury	Asphalt	241	LF	$12.87	$3,101
MH A2-2 to MH A2-3	3" (80) Cond	Direct Bury	Conc Road	42	LF	$18.02	$757
Through Bldg 3	2" (80) Cond	-	-	1	EA	$62.25	$62
Through Bldg 35	2" (80) Cond	-	-	1	EA	$62.25	$62
Bldg 35 to Bldg 36	2" (40) HPS	Direct Bury	Conc Road	20	LF	$18.02	$360
Bldg 35 to Bldg 36	2" (80) Cond	Direct Bury	Conc Road	20	LF	$18.02	$360
Bldg 35 to Bldg 36	2" (40) HPS	Direct Bury	Lawn	76	LF	$4.77	$363
Bldg 35 to Bldg 36	2" (80) Cond	Direct Bury	Lawn	76	LF	$4.77	$363
						Total =	$15,502

CONSTRUCTION COST ESTIMATE				Date Prepared Sep - 95		Sheet 4 of 11	
Project: ECIP Modernize Industrial AreasSteam Distribution				Project No. PN-40667		Basis for Estimate	
Location: Hawthorne Army Ammunition Depot, Nevada				Code A (no design completed)			
Engineer-Architect: Keller & Gannon							
Drawing No. **Reroute Pipes for Buildings 3, 35 & 36**				Estimator **BIH**		Checked By **RCL**	
Location	Service	Placement	Surface	Quantity No. Units	Quantity Unit Meas.	Unit Cost	Total Cost
Elbow cost							
MH A2-1 to MH A2-2	2" (40) HPS ELB	Direct Bury	Asphalt	4	EA	$276	$1,103
MH A2-2 to MH A2-3	2" (40) HPS ELB	Direct Bury	Asphalt	4	EA	$276	$1,103
MH A2-1 to MH A2-2	3" (80) Cond ELB	Direct Bury	Asphalt	4	EA	$392	$1,567
MH A2-2 to MH A2-3	4" (80) Cond ELB	Direct Bury	Asphalt	4	EA	$456	$1,824
						Total =	$5,598
Core Drill cost							
Through Bldg 3	2" (40) HPS			2	EA	$351	$701
Through Bldg 3	2" (80) Cond			2	EA	$351	$701
Through Bldg 35	2" (40) HPS			2	EA	$351	$701
Through Bldg 35	2" (80) Cond			2	EA	$351	$701
						Total =	$2,806
Fittings cost							
MH A2-2	2" (40) HPS ' T '			2	EA	$163	$325
	2" (40) HPS ' 45° EL '			1	EA	$121	$121
	1 1/2" Drip Trap Ass.			1	EA	$1,999	$1,999
	3" (80) Cond ' T '			2	EA	$247	$494
	3" (80) Cond ' 90° EL '			1	EA	$171	$171
	Anchors			2	EA	$39	$78
MH A2-3	2" (40) HPS ' T '			1	EA	$41	$41
	2" HPS Valve			1	EA	$282	$282
	2" (80) Cond ' T '			1	EA	$217	$217
	2" Cond Valve			1	EA	$282	$282
Expansion Joints	None Required, Loops are installed						$0
						Total =	$4,010
Subtotal							**$112,413**
Nevada Sales Tax	3.75%	Based on average of materials costs				54%	$2,276
Subtotal							$114,688
Contractor OH & Profit	25.0%						$28,672
Subtotal							$143,360
Estimating Contingency	10.0%						$14,336
Total Probable Construction Cost							**$157,696**
Average Cost per Linear Foot Including Steam and Condensate Piping & Fittings							$119.83

CONSTRUCTION COST ESTIMATE				Date Prepare: Sep - 95		Sheet: 5	of: 11
Project: ECIP Modernize Industrial Area Steam Distribution				Project No.: PN-40667		Basis for Estimate:	
Location: Hawthorne Army Ammunition Depot, Nevada				Code A (no design completed)			
Engineer-Architect: Keller & Gannon							
Drawing No.: **Replace Steam Piping - U Street East**				Estimator: **BIH**		Checked By: **RCL**	
Location	Service	Placement	Surface	Quantity No. Units	Quantity Unit Meas.	Unit Cost	Total Cost
Piping cost							
MH A9 to MH EJ3	2 1/2" (80) Cond	Conc Trench	Conc	140	LF	$32.19	$4,506
MH A10 to Bldg 42	2" (40) HPS	Conc Trench	Conc	75	LF	$26.71	$2,003
MH A10 to Bldg 42	2" (80) Cond	Conc Trench	Conc	75	LF	$25.01	$1,875
MH A10 to MH A11	4" (40) HPS	Conc Trench	Conc	300	LF	$44.37	$13,312
MH A10 to MH A11	2 1/2" (80) Cond	Conc Trench	Conc	300	LF	$32.19	$9,657
MH A11 to MH A11J	2 1/2" (80) Cond	Conc Trench	Conc	20	LF	$32.19	$644
MH A11 to A11-3	2 1/2" (40) LPS	Conc Trench	Conc	350	LF	$31.26	$10,940
MH A11-3 to P26	2 1/2" (40) LPS	Conc Trench	Conc	150	LF	$31.26	$4,689
MH A11-1 to V	2" (40) LPS	Conc Trench	Conc	40	LF	$26.71	$1,068
MH P21 to U	2" (40) LPS	Conc Trench	Conc	40	LF	$26.71	$1,068
MH A11-2 to T	2" (40) LPS	Conc Trench	Conc	40	LF	$26.71	$1,068
MH P22 To S	2 1/2" (40) LPS	Conc Trench	Conc	40	LF	$31.26	$1,250
MH A11-3 to R	2 1/2" (40) LPS	Conc Trench	Conc	40	LF	$31.26	$1,250
MH P23 to Q	2 1/2" (40) LPS	Conc Trench	Conc	50	LF	$31.26	$1,563
MH P24 to P	2 1/2" (40) LPS	Conc Trench	Conc	55	LF	$31.26	$1,719
MH P25 to O	2 1/2" (40) LPS	Conc Trench	Conc	40	LF	$31.26	$1,250
MH P25 to MH P26	2 1/2" (40) LPS	Conc Trench	Conc	80	LF	$31.26	$2,501
						Total =	$60,366
Demolition cost (Assumed existing abandoned condensate pipe in trench is the same size as in parallel return line.)							
MH A9 to MH EJ3	2 1/2" (80) Cond	Conc Trench	Conc	140	LF	$0.00	$0
MH A10 to Bldg 42	2" (40) HPS	Conc Trench	Conc	75	LF	$1.56	$117
MH A10 to Bldg 42	2" (80) Cond	Conc Trench	Conc	75	LF	$1.17	$88
MH A10 to MH A11	4" (40) HPS	Conc Trench	Conc	300	LF	$1.56	$468
MH A10 to MH A11	2 1/2" (80) Cond	Conc Trench	Conc	300	LF	$0.00	$0
MH A11 to MH A11J	2 1/2" (80) Cond	Conc Trench	Conc	20	LF	$0.00	$0
MH A11 to A11-3	2 1/2" (40) LPS	Conc Trench	Conc	350	LF	$1.56	$546
MH A11-3 to P26	2 1/2" (40) LPS	Conc Trench	Conc	150	LF	$1.56	$234
MH A11-1 to V	2" (40) LPS	Conc Trench	Conc	40	LF	$1.56	$62
MH P21 to U	2" (40) LPS	Conc Trench	Conc	40	LF	$1.56	$62
MH A11-2 to T	2" (40) LPS	Conc Trench	Conc	40	LF	$1.56	$62
MH P22 To S	2 1/2" (40) LPS	Conc Trench	Conc	40	LF	$1.56	$62
MH A11-3 to R	2 1/2" (40) LPS	Conc Trench	Conc	40	LF	$1.56	$62
MH P23 to Q	2 1/2" (40) LPS	Conc Trench	Conc	50	LF	$1.56	$78
MH P24 to P	2 1/2" (40) LPS	Conc Trench	Conc	55	LF	$1.56	$86
MH P25 to O	2 1/2" (40) LPS	Conc Trench	Conc	40	LF	$1.56	$62
MH P25 to MH P26	2 1/2" (40) LPS	Conc Trench	Conc	80	LF	$1.56	$125
						Total =	$2,116

CONSTRUCTION COST ESTIMATE				Date Prepare: Sep - 95		Sheet: 6	of: 11
Project: ECIP Modernize Industrial Area Steam Distribution				Project No.: PN-40667		Basis for Estimate	
Location: Hawthorne Army Ammunition Depot, Nevada				Code A (no design completed)			
Engineer-Architect: Keller & Gannon							
Drawing No.: **Replace Steam Piping - U Street East**				Estimator: **BIH**		Checked By: **RCL**	
Location	Service	Placement	Surface	Quantity No. Units	Quantity Unit Meas.	Unit Cost	Total Cost
Construction cost							
MH A9 to MH EJ3	2 1/2" (80) Cond	Conc Trench	Conc	140	LF	$3.18	$445
MH A10 to Bldg 42	2" (40) HPS	Conc Trench	Conc	75	LF	$3.18	$238
MH A10 to Bldg 42	2" (80) Cond	Conc Trench	Conc	75	LF	$3.18	$238
MH A10 to MH A11	4" (40) HPS	Conc Trench	Conc	300	LF	$3.18	$953
MH A10 to MH A11	2 1/2" (80) Cond	Conc Trench	Conc	300	LF	$3.18	$953
MH A11 to MH A11J	2 1/2" (80) Cond	Conc Trench	Conc	20	LF	$3.18	$64
MH A11 to A11-3	2 1/2" (40) LPS	Conc Trench	Conc	350	LF	$3.18	$1,112
MH A11-3 to P26	2 1/2" (40) LPS	Conc Trench	Conc	150	LF	$3.18	$477
MH A11-1 to V	2" (40) LPS	Conc Trench	Conc	40	LF	$3.18	$127
MH P21 to U	2" (40) LPS	Conc Trench	Conc	40	LF	$3.18	$127
MH A11-2 to T	2" (40) LPS	Conc Trench	Conc	40	LF	$3.18	$127
MH P22 To S	2 1/2" (40) LPS	Conc Trench	Conc	40	LF	$3.18	$127
MH A11-3 to R	2 1/2" (40) LPS	Conc Trench	Conc	40	LF	$3.18	$127
MH P23 to Q	2 1/2" (40) LPS	Conc Trench	Conc	50	LF	$3.18	$159
MH P24 to P	2 1/2" (40) LPS	Conc Trench	Conc	55	LF	$3.18	$175
MH P25 to O	2 1/2" (40) LPS	Conc Trench	Conc	40	LF	$3.18	$127
MH P25 to MH P26	2 1/2" (40) LPS	Conc Trench	Conc	80	LF	$3.18	$254
						Total =	$5,830
Fittings cost							
MH A10	4"(40) HPS ' T '			2	EA	$286	$572
	4"(40) HPS ' 45° EL '			2	EA	$206	$412
	1 1/2" Drip Trap ASS.			1	EA	$1,999	$1,999
	2" HPS Valve			1	EA	$282	$282
	2 1/2" (80) Cond ' T '			2	EA	$217	$435
	2 1/2" (80) Cond ' 90° EL '			1	EA	$153	$153
	2" Cond Valve			1	EA	$282	$282
MH A11	6"(40) HPS ' 45° EL '			2	EA	$206	$412
	6"(40) HPS Guide			1	EA	$155	$155
	6" HPS Valve			1	EA	$1,742	$1,742
	8" (40) HPS ' T '			2	EA	$2,627	$5,253
	8" (40) HPS ' Guide '			1	EA	$293	$293
	Anchor			1	EA	$47	$47
	8" HPS Valve			1	EA	$2,627	$2,627
	1 1/2" Drip Trap ASS.			1	EA	$1,999	$1,999
	1 1/2" (80) Cond ' 90° EL '			5	EA	$110	$551
	3" (80) Cond ' 90° EL '			1	EA	$174	$174
	3" (80) Cond ' Guide '			1	EA	$92	$92
	3" Cond Valve			1	EA	$874	$874
	4" (80) Cond ' T '			2	EA	$336	$673
	4" (80) Cond ' Guide '			1	EA	$155	$155
	Anchor			1	EA	$43	$43
	4" Cond Valve			1	EA	$1,132	$1,132

CONSTRUCTION COST ESTIMATE				Date Prepare: Sep - 95		Sheet: 7 of 11	
Project: ECIP Modernize Industrial Area Steam Distribution				Project No.: PN-40667		Basis for Estimate	
Location: Hawthorne Army Ammunition Depot, Nevada				Code A (no design completed)			
Engineer-Architect: Keller & Gannon							
Drawing No.: **Replace Steam Piping - U Street East**				Estimator: **BIH**		Checked By: **RCL**	
Location	Service	Placement	Surface	Quantity No. Units	Quantity Unit Meas.	Unit Cost	Total Cost
MH A11-1	3" (40) LPS ' T '			1	EA	$341	$341
	3" (40) LPS ' 45° EL '			1	EA	$157	$157
	1 1/2" Drip Trap ASS.			1	EA	$1,999	$1,999
	2" LPS Valve			1	EA	$282	$282
MH P21	3" (40) LPS ' T '			1	EA	$341	$341
	3" (40) LPS ' 45° EL '			1	EA	$157	$157
	2" LPS Valve			1	EA	$282	$282
MH A11-2	3" (40) LPS ' T '			1	EA	$341	$341
	3" (40) LPS ' 45° EL '			1	EA	$157	$157
	2" LPS Valve			1	EA	$282	$282
MH P22	3" (40) LPS ' T '			1	EA	$341	$341
	3" (40) LPS ' 45° EL '			1	EA	$157	$157
	2 1/2" LPS Valve			1	EA	$858	$858
MH A11-3	3" (40) LPS ' T '			1	EA	$341	$341
	3" (40) LPS ' 45° EL '			1	EA	$157	$157
	2 1/2" LPS Valve			1	EA	$858	$858
MH P23	3" (40) LPS ' T '			1	EA	$341	$341
	3" (40) LPS ' 45° EL '			1	EA	$157	$157
	2 1/2" LPS Valve			1	EA	$858	$858
MH P24	3" (40) LPS ' T '			1	EA	$341	$341
	3" (40) LPS ' 45° EL '			1	EA	$157	$157
	2 1/2" LPS Valve			1	EA	$858	$858
MH P25	3" (40) LPS ' T '			1	EA	$341	$341
	3" (40) LPS ' 45° EL '			1	EA	$157	$157
	2 1/2" LPS Valve			1	EA	$858	$858
MH P26	3" (40) LPS ' T '			1	EA	$341	$341
	3" (40) LPS ' 45° EL '			1	EA	$157	$157
	2 1/2" LPS Valve			1	EA	$858	$858
Expansion Joints	6" Steam or Condensate			1	EA	$748	$748
	5" Steam or Condensate			2	EA	$724	$1,448
	4" Steam or Condensate			7	EA	$575	$4,028
	3" Steam or Condensate			11	EA	$481	$5,291
						Total =	$44,341
Subtotal							**$112,653**
Nevada Sales Tax	3.75%	Based on average of materials costs				54%	$2,280
Subtotal							$114,933
Contractor OH & Profit	25.0%						$28,733
Subtotal							$143,666
Estimating Contingency	10.0%						$14,367
Total Probable Construction Cost							**$158,033**
Average Cost per Linear Foot Including Steam and Condensate Piping & Fittings							$86.12

CONSTRUCTION COST ESTIMATE				Date Prepared Sep - 95		Sheet 8	of 11
Project: ECIP Modernize Industrial Area Steam Distribution				Project No. PN-40667		Basis for Estimate	
Location: Hawthorne Army Ammunition Depot, Nevada				Code A (no design completed)			
Engineer-Architect: Keller & Gannon							
Drawing No. **Replace Family Housing Condensate Pipes**				Estimator **BIH**		Checked By **RCL**	
Location	Service	Placement	Surface	Quantity No. Units	Quantity Unit Meas.	Unit Cost	Total Cost
Piping cost							
MH A13 to MH A14	1" (80) Cond	Conc Trench	Conc	300	LF	$18.20	$5,461
MH A13 to MH A14	1" (80) Cond	Conc Trench	Conc Road	19	LF	$18.20	$346
MH A14 to MH A15	2" (80) Cond	Conc Trench	Conc	100	LF	$25.01	$2,501
MH A15 to MH A14	1 1/2" (80) Cond	Conc Trench	Conc	100	LF	$20.00	$2,000
MH A15 to MH A16	2" (80) Cond	Conc Trench	Conc	95	LF	$25.01	$2,376
MH A17-1 to A16	1" (80) Cond	Conc Trench	Conc	95	LF	$18.20	$1,729
MH A17-1 to A16	1 1/2" (80) Cond	Conc Trench	Conc	95	LF	$20.00	$1,900
MH A18 to A17-1	1" (80) Cond	Conc Trench	Conc	330	LF	$18.20	$6,007
MH A18 to A17-1	1" (80) Cond	Conc Trench	Conc Road	20	LF	$18.20	$364
MH A14 to F/179	1 1/2" (80) Cond	Conc Trench	Conc	33	LF	$20.00	$660
MH A15 to E/178	1 1/2" (80) Cond	Conc Trench	Conc	44	LF	$20.00	$880
MH A16 to D/177	1 1/2" (80) Cond	Conc Trench	Conc	44	LF	$20.00	$880
MH A17-1 to C/176	1 1/2" (80) Cond	Conc Trench	Conc	44	LF	$20.00	$880
MH A17 to B/175	1 1/2" (80) Cond	Conc Trench	Conc	44	LF	$20.00	$880
MH A18 to A/174	2" (80) Cond	Conc Trench	Conc	65	LF	$25.01	$1,625
MH A18 to A/174	2" (80) Cond	Conc Trench	Conc Road	15	LF	$25.01	$375
MH A16 to N-1	2" (80) Cond	Direct Bury	Lawn	311	LF	$48.67	$15,136
MH A16 to N-1	2" (80) Cond	Direct Bury	Conc Road	40	LF	$48.67	$1,947
MH A16 to N-1	2" (80) Cond	Direct Bury	Sidewalk	5	LF	$48.67	$243
MH N-1 to DD/291	1 1/2" (80) Cond	Direct Bury	Lawn	35	LF	$48.34	$1,692
MH N-1 to N-2	2" (80) Cond	Direct Bury	Lawn	120	LF	$48.67	$5,840
MH N-1 to N-2	2" (80) Cond	Direct Bury	Sidewalk	10	LF	$48.67	$487
MH N-2 to CC/290	1 1/2" (80) Cond	Direct Bury	Lawn	35	LF	$48.34	$1,692
MH N-2 to N-3	2" (80) Cond	Direct Bury	Lawn	514	LF	$48.67	$25,016
MH N-2 to N-3	2" (80) Cond	Direct Bury	Conc Road	20	LF	$48.67	$973
MH N-3 to 292-2	1 1/2" (80) Cond	Direct Bury	Lawn	40	LF	$48.34	$1,934
MH N-3 to N-4	2" (80) Cond	Direct Bury	Lawn	100	LF	$48.67	$4,867
MH N-3 to N-4	2" (80) Cond	Direct Bury	Conc Road	20	LF	$48.67	$973
MH N-4 to N-5	2" (80) Cond	Direct Bury	Lawn	362	LF	$48.67	$17,619
MH N-4 to N-5	2" (80) Cond	Direct Bury	Conc Road	40	LF	$48.67	$1,947
MH N-4 to N-5	2" (80) Cond	Direct Bury	Sidewalk	10	LF	$48.67	$487
MH N-5 to N-6	2" (80) Cond	Direct Bury	Lawn	454	LF	$48.67	$22,096
MH N-5 to N-6	2" (80) Cond	Direct Bury	Conc Road	40	LF	$48.67	$1,947
						Total =	$133,759
Demolition cost (Assumed existing abandoned condensate pipe in trench is the same size as in parallel return line.)							
MH A13 to MH A14	1" (80) Cond	Conc Trench	Conc	300	LF	$1.17	$351
MH A15 to MH A14	1 1/2" (80) Cond	Conc Trench	Conc	100	LF	$1.17	$117
MH A15 to MH A16	2" (80) Cond	Conc Trench	Conc	95	LF	$1.17	$111
MH A17-1 to A16	1" (80) Cond	Conc Trench	Conc	95	LF	$1.17	$111
MH A17-1 to A16	1 1/2" (80) Cond	Conc Trench	Conc	95	LF	$1.17	$111
MH A18 to A17-1	1" (80) Cond	Conc Trench	Conc	330	LF	$1.17	$386

CONSTRUCTION COST ESTIMATE

Date Prepared: Sep - 95	Sheet: 9	of: 11
Project: ECIP Modernize Industrial Area Steam Distribution	Project No.: PN-40667	Basis for Estimate:
Location: Hawthorne Army Ammunition Depot, Nevada	Code A (no design completed)	
Engineer-Architect: Keller & Gannon		
Drawing No.: **Replace Family Housing Condensate Pipes**	Estimator: **BIH**	Checked By: **RCL**

Location	Service	Placement	Surface	Quantity No. Units	Quantity Unit Meas.	Unit Cost	Total Cost
MH A18 to A17-1	1" (80) Cond	Conc Trench	Conc Road	20	LF	$1.17	$23
MH A14 to F/179	1 1/2" (80) Cond	Conc Trench	Conc	33	LF	$1.17	$39
MH A15 to E/178	1 1/2" (80) Cond	Conc Trench	Conc	44	LF	$1.17	$51
MH A16 to D/177	1 1/2" (80) Cond	Conc Trench	Conc	44	LF	$1.17	$51
MH A17-1 to C/176	1 1/2" (80) Cond	Conc Trench	Conc	44	LF	$1.17	$51
MH A17 to B/175	1 1/2" (80) Cond	Conc Trench	Conc	44	LF	$1.17	$51
MH A18 to A/174	2" (80) Cond	Conc Trench	Conc	65	LF	$1.17	$76
MH A18 to A/174	2" (80) Cond	Conc Trench	Conc Road	15	LF	$1.17	$18
						Total =	$1,549
Construction total cost							
MH A13 to MH A14	1" (80) Cond	Conc Trench	Conc	300	LF	$3.18	$953
MH A13 to MH A14	1" (80) Cond	Conc Trench	Conc Road	19	LF	$17.62	$335
MH A14 to MH A15	2" (80) Cond	Conc Trench	Conc	100	LF	$3.18	$318
MH A15 to MH A14	1 1/2" (80) Cond	Conc Trench	Conc	100	LF	$3.18	$318
MH A15 to MH A16	2" (80) Cond	Conc Trench	Conc	95	LF	$3.18	$302
MH A17-1 to A16	1" (80) Cond	Conc Trench	Conc	95	LF	$3.18	$302
MH A17-1 to A16	1 1/2" (80) Cond	Conc Trench	Conc	95	LF	$3.18	$302
MH A18 to A17-1	1" (80) Cond	Conc Trench	Conc	330	LF	$3.18	$1,048
MH A18 to A17-1	1" (80) Cond	Conc Trench	Conc Road	20	LF	$17.62	$352
MH A14 to F/179	1 1/2" (80) Cond	Conc Trench	Conc	33	LF	$3.18	$105
MH A15 to E/178	1 1/2" (80) Cond	Conc Trench	Conc	44	LF	$3.18	$140
MH A16 to D/177	1 1/2" (80) Cond	Conc Trench	Conc	44	LF	$3.18	$140
MH A17-1 to C/176	1 1/2" (80) Cond	Conc Trench	Conc	44	LF	$3.18	$140
MH A17 to B/175	1 1/2" (80) Cond	Conc Trench	Conc	44	LF	$3.18	$140
MH A18 to A/174	2" (80) Cond	Conc Trench	Conc	65	LF	$3.18	$207
MH A18 to A/174	2" (80) Cond	Conc Trench	Conc Road	15	LF	$17.62	$264
MH A16 to N-1	2" (80) Cond	Direct Bury	Lawn	311	LF	$4.77	$1,483
MH A16 to N-1	2" (80) Cond	Direct Bury	Conc Road	40	LF	$18.02	$721
MH A16 to N-1	2" (80) Cond	Direct Bury	Sidewalk	5	LF	$12.87	$64
MH N-1 to DD/291	1 1/2" (80) Cond	Direct Bury	Lawn	35	LF	$4.77	$167
MH N-1 to N-2	2" (80) Cond	Direct Bury	Lawn	120	LF	$4.77	$572
MH N-1 to N-2	2" (80) Cond	Direct Bury	Sidewalk	10	LF	$12.87	$129
MH N-2 to CC/290	1 1/2" (80) Cond	Direct Bury	Lawn	35	LF	$4.77	$167
MH N-2 to N-3	2" (80) Cond	Direct Bury	Lawn	514	LF	$4.77	$2,452
MH N-2 to N-3	2" (80) Cond	Direct Bury	Conc Road	20	LF	$18.02	$360
MH N-3 to 292-2	1 1/2" (80) Cond	Direct Bury	Lawn	40	LF	$4.77	$191
MH N-3 to N-4	2" (80) Cond	Direct Bury	Lawn	100	LF	$4.77	$477
MH N-3 to N-4	2" (80) Cond	Direct Bury	Conc Road	20	LF	$18.02	$360
MH N-4 to N-5	2" (80) Cond	Direct Bury	Lawn	362	LF	$4.77	$1,727
MH N-4 to N-5	2" (80) Cond	Direct Bury	Conc Road	40	LF	$18.02	$721
MH N-4 to N-5	2" (80) Cond	Direct Bury	Sidewalk	10	LF	$12.87	$129
MH N-5 to N-6	2" (80) Cond	Direct Bury	Lawn	454	LF	$4.77	$2,166
MH N-5 to N-6	2" (80) Cond	Direct Bury	Conc Road	40	LF	$18.02	$721
						Total =	$11,120

CONSTRUCTION COST ESTIMATE				Date Prepared Sep - 95		Sheet 10	of 11
Project ECIP Modernize Industrial Area Steam Distribution				Project No. PN-40667		Basis for Estimate	
Location Hawthorne Army Ammunition Depot, Nevada				Code A (no design completed)			
Engineer-Architect Keller & Gannon							
Drawing No. **Replace Family Housing Condensate Pipes**				Estimator **BIH**		Checked By **RCL**	
Location	Service	Placement	Surface	Quantity No. Units	Quantity Unit Meas.	Unit Cost	Total Cost
Elbow cost							
MH A16 to N-1	2" (80) Cond	Direct Bury	Lawn	4	EA	$322	$1,287
MH N-1 to N-2	2" (80) Cond	Direct Bury	Lawn	4	EA	$322	$1,287
MH N-2 to N-3	2" (80) Cond	Direct Bury	Lawn	8	EA	$322	$2,574
MH N-4 to N-5	2" (80) Cond	Direct Bury	Lawn	8	EA	$322	$2,574
MH N-5 to N-6	2" (80) Cond	Direct Bury	Lawn	4	EA	$322	$1,287
						Total =	$9,009
Manhole cost							
N-1				1	EA	$6,266	$6,266
N-2				1	EA	$6,266	$6,266
N-3				1	EA	$6,266	$6,266
N-4				1	EA	$6,266	$6,266
N-5				1	EA	$6,266	$6,266
N-6				1	EA	$6,266	$6,266
						Total =	$37,596
Fittings cost							
MH A13	1" Cond (80) ' T '			2	EA	$124	$249
	1" Cond (80) ' 90° EL '			1	EA	$97	$97
	2" Cond Valve			1	EA	$282	$282
MH A14	2" Cond (80) ' T '			2	EA	$181	$362
	2" Cond (80) ' 90° EL '			1	EA	$135	$135
	1 1/2" Cond Valve			1	EA	$217	$217
MH A15	2" Cond (80) ' T '			1	EA	$181	$181
	1 1/2" Cond Valve			1	EA	$217	$217
MH A16	1 1/2" (80) Cond ' T '			2	EA	$151	$301
	1 1/2" Cond Valve			1	EA	$217	$217
MH A17	1" Cond (80) ' T '			1	EA	$124	$124
	1" Cond (80) ' 90° EL '			1	EA	$97	$97
	1 1/2" Cond Valve			1	EA	$217	$217
MH A18	1" Cond (80) ' 90° EL '			1	EA	$97	$97
	2" Cond Valve			1	EA	$282	$282
MH A16 to N-1	2" (80) Cond ' 90° EL '			1	EA	$135	$135
	Anchors			2	EA	$35	$69
MH N-1	2" Cond (80) ' T '			2	EA	$181	$362
	2" (80) Cond ' 90° EL '			1	EA	$135	$135
	Anchors			1	EA	$35	$35
	1 1/2" Cond Valve			1	EA	$217	$217
MH N-2	2" Cond (80) ' T '			1	EA	$181	$181
	Anchors			2	EA	$35	$69
	1 1/2" Cond Valve			1	EA	$217	$217
MH N-2 to N-3	2" (80) Cond ' 90° EL '			4	EA	$135	$540
	Anchors			2	EA	$35	$69

CONSTRUCTION COST ESTIMATE				Date Prepared Sep - 95		Sheet 11 of 11	
Project: ECIP Modernize Industrial Area Steam Distribution				Project No. PN-40667		Basis for Estimate	
Location: Hawthorne Army Ammunition Depot, Nevada				Code A (no design completed)			
Engineer-Architect: Keller & Gannon							
Drawing No. **Replace Family Housing Condensate Pipes**				Estimator **BIH**		Checked By **RCL**	
Location	Service	Placement	Surface	Quantity No. Units	Quantity Unit Meas.	Unit Cost	Total Cost
MH N-3	2" Cond (80) ' T '			2	EA	$181	$362
	2" (80) Cond ' 90° EL '			1	EA	$135	$135
	Anchors			1	EA	$35	$35
	2" Cond Valve			1	EA	$282	$282
MH N-4	2" Cond (80) ' T '			2	EA	$181	$362
	Anchors			1	EA	$35	$35
	2" Cond Valve			2	EA	$282	$564
MH N-4 to MH N-5	Anchors			2	EA	$35	$69
Mh N-5	2" Cond (80) ' T '			1	EA	$181	$181
	Anchors			2	EA	$35	$69
	2" Cond Valve			1	EA	$282	$282
MH N-6	2" Cond (80) ' T '			2	EA	$181	$362
	2" (80) Cond ' 90° EL '			1	EA	$135	$135
	Anchors			1	EA	$35	$35
Expansion Joints	None Required, Loops are installed						$0
						Total =	$8,007
Subtotal							**$201,041**
Nevada Sales Tax	3.75%	Based on average of materials costs				54%	$4,070
Subtotal							$205,110
Contractor OH & Profit	25.0%						$51,278
Subtotal							$256,388
Estimating Contingency	10.0%						$25,639
Total Probable Construction Cost							**$282,027**
Average Cost per Linear Foot Including Steam and Condensate Piping & Fittings							$78.36

1. COMPONENT	FY 1996 MILITARY CONSTRUCTION PROJECT DATA	2. DATE
Army		September 1995

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
Hawthorne Army Ammunition Depot Nevada	ECIP Modernize Ordnance Area Steam Distribution

5. PROGRAM ELEMENT	6. CATEGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
	8000	42166	1,242.8

9. COST ESTIMATES

Item	U/M	Quantity	Unit Cost	Cost ($000)
Primary Facilities, above ground and direct buried piping replacements:				976.3
Manhole A5 to Manhole A11	LF	3,538	136.69	(483.6)
Manhole D2 to Manhole D4	LF	1,336	130.15	(173.9)
Manhole A18 to Building 108-20	LF	642	128.63	(82.6)
Manhole A5 to Building 103-40	LF	710	54.49	(38.8)
Building 103-6 to Manhole C3	LF	1,394	109.14	(152.1)
Manhole B8 to Manhole B9-1	LF	560	81.05	(45.4)
Supporting Facilities	LS	—	—	0
Estimated Contract Cost				976.3
Contingency 10%				97.6
Subtotal				1,074.0
Supervision, Inspection and Overhead 5.6%				60.1
Design 6%				64.4
Unescalated CWE				1,198.5
Escalation to Midpoint of Construction: 1 December 1996				44.3
Total Request				1,242.8

10. DESCRIPTION OF PROPOSED CONSTRUCTION

Replace about 8,180 linear feet of steam and condensate return piping in the Ordnance Area. Replacement piping will be above ground as much as possible to reduce repair costs and to improve reliability. Street and railroad crossings will be made via separate preengineered conduit piping systems. The above ground piping systems will be built up systems with service pipe and field installed insulation and aluminum jacketing. Steam service piping will be schedule 40 steel and condensate return piping will be schedule 80 steel for both above and underground systems. Insulation and conduit for the underground replacement piping will be as specified in Corps of Engineers Guide Specification (CEGS) 02695, Preapproved Underground Heat Distribution System. Insulation and aluminum jacketing for above ground replacement piping will be sized and field installed in accordance with the latest requirements of CEGS 02697, Aboveground Heat Distribution System.

Validation of savings: Energy savings will be measured by comparing the fuel consumption for the heating plant in building 103-6 before and after the new steam and condensate piping is installed. The heating requirements, including heating degree days and building utilization, will be taken into account when comparing the consumption values.

DD FORM 1391

11. REQUIREMENT: N.A. **ADEQUATE**: N.A. **SUBSTANDARD**: N.A.

PROJECT: Replace approximately 8,180 LF of selected steam and condensate return piping in the Ordnance Area currently direct buried or installed in shallow concrete trenches.

REQUIREMENT: This project will contribute toward achieving Department of Defense facility energy goals of a 20-percent reduction in energy use per gross square feet by FY2000 versus FY1985 baseline levels.

This project will save $220,708 annually, comprised of $101,447 from fuel oil savings and $119,261 per year from maintenance cost savings. These savings result in a 5.43-year simple payback period and a savings-to-investment ratio of 2.39. Annual fuel savings are estimated at 16,549 Million BTU per year.

CURRENT SITUATION: Selected existing buried steam supply and condensate return piping is in a deteriorated state. Much of this piping is over twenty years old and is corroded. Insulation is deteriorated and leakage of steam and condensate is prevalent. Repairs to the existing systems are required frequently and are becoming more costly due to the deteriorated state of the systems and the need to excavate to locate the leaks.

IMPACT IF NOT PROVIDED: If this project is not accomplished, annual expenses of about $220,708 for fuel and maintenance will be incurred that could have been avoided. Additionally, the potential of losing heating service to buildings served will be greatly increased. If this project is not approved, it will have a negative impact on the HWAAD energy program and will impede progress towards compliance with DEPPM 91-2.

ADDITIONAL: This project has been coordinated with the installation security plan, and no security improvements are required. This project incorporates recommendations of the Energy Engineering Analysis Program, Limited Energy Study of Steam Distribution Systems, performed under Contract No. DACA05-92-C-0155.

This installation is not under consideration for realignment or closure.

JOHN G. ZODROW
Lt. Colonel
Commanding

Estimate Date: 1 September 1995	Index: 1975
Estimated Construction Start: 1 September 1996	Index: 2032
Estimated Midpoint of Construction: 1 December 1996	Index: 2048
Estimated Construction Completion: 1 March 1997	Index: 2060

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Detailed Justification

1. GENERAL: The project is a significant part of Hawthorne Army Ammunition Depot's effort to achieve a 20-percent reduction in energy consumption by FY2000 versus FY1985 baseline levels. The project will also assure that heating services are provided to Ordnance Area facilities on a continuing basis, supporting mission requirements.

2. ACCOMMODATIONS NOW IN USE: Not applicable.

3. ANALYSIS OF DEFICIENCY: The present condition of steam distribution and condensate collection piping contributes to unnecessary annual energy consumption and maintenance expenses totaling about $220,708 per year. These costs will be avoided with implementation of the proposed project.

4. CONSIDERATION OF ALTERNATIVES: Alternative piping materials and placement methods were considered. The least costly alternatives are recommended for implementation. The recommended retrofits are those selected in the Limited Energy Study of Steam Distribution Systems, September 1995, prepared under Contract No. DACA 05-C-92-0155.

5. CRITERIA FOR PROPOSED CONSTRUCTION: Design and construction will be in accordance with applicable criteria established in:
   a. DOD 4270.1-M
   b. TM 810-5
   c. Architectural and Engineering Instruction, dated 9 December 1991
   d. A-E Guide Instruction for Army Projects, Volume 1, dated January 1990
   e. A-E Guide, CESPK Cost Estimating Guide, Volume 2, dated December 1989
   f. A-E Guide Volume III, Specifications, dated December 1990
   g. Energy Conservation Investment Program (ECIP) Guidance, dated 10 January 1994.
   h. TM 5-785, Engineering Weather Data
   i. MCASES instructions
   j. TM 5-652, Steam / Hot Water and Chilled Water Distribution Systems Operations and Maintenance Manual
   k. CEGS-02695, Preapproved Underground Heat Distribution System
   l. CEGS-02696, Heat Distribution Systems in Concrete Trenches
   m. CEGS-02697, Aboveground Heat Distribution System

6. PROGRAM FOR RELATED FURNISHINGS AND EQUIPMENT: Not applicable.

7. DISPOSAL OF PRESENT ASSETS: Not applicable.

8. SURVIVAL MEASURES: Not applicable.

9. SUMMARY OF ENVIRONMENTAL CONSEQUENCES: Atmospheric emissions will be reduced as less fuel will be used due to this project. Temporary conditions will exist during the construction period consisting primarily of fugitive dust emissions.

10. EVALUATION OF FLOOD HAZARDS AND ENCROACHMENT ON WETLANDS: Not applicable

11. ECONOMIC JUSTIFICATION: In accordance with ECIP Guidance dated 10 December 1994, an economic analysis has been prepared. Life-cycle cost analysis results are summarized as follows:

• Estimated Construction Cost (including SIOH and design costs)	$1,198,535
• Annual Energy Savings	16,549 MBTU (2,907,250 MJ)
• First Year Energy Cost Savings	$101,447
• First Year Non-energy Cost Savings	$119,261
• Total First Year Cost Savings	$220,708
• Discounted Energy Savings	$1,443,592
• Discounted Non-energy savings	$1,423,970
• Total Net Discounted Savings	$2,867,562
• Savings-to-Investment Ratio	2.39
• Simple Payback Period	5.43 years

Refer to "Detailed Calculations" for backup data.

12. UTILITY AND TELECOMMUNICATIONS SUPPORT: Not applicable.

13. PROTECTION OF HISTORIC PLACES AND ARCHEOLOGICAL SITES: Review procedures have been implemented for this project in accordance with 36 CFR 800. The review has established that there will be no effect.

14. PROJECT DEVELOPMENT BROCHURE: A Project Development Brochure (PDB-1) dated September 1995 has been prepared.

15. ENERGY REQUIREMENTS: Not applicable.

16. PROVISION FOR THE HANDICAPPED: Not applicable.

17. REAL PROPERTY MAINTENANCE ACTIVITY ANALYSIS: Not applicable.

18. COMMERCIAL ACTIVITIES: This project involves replacement or modification of existing systems for energy conservation. Under these conditions, the provisions of AR 5-XX do not apply, and a "new start or expansion" is not required.

Life Cycle Cost Analysis Summary - Ordnance Area
Energy Conservation Investment Program (ECIP)

Location: Hawthorne Army Ammunition Depot Region No. 4 Project No. 42166
Project Title: ECIP Modernize Ordnance Area Steam Distribution Fiscal Year FY97
Discrete Portion: Total Project Preparer: KELLER & GANNON
Analysis Date September 1995 Economic Life: 15 Years

1. Investment Costs			
A. Construction Costs	$1,073,956		
B. SIOH 5.6%	$60,142		
C. Design Cost 6.0%	$64,437		
D. Total Cost (1A+1B+1C)	$1,198,535		
E. Salvage Value of Existing Equipment		$0	
F. Public Utility Company Rebate		$0	
G. Total Investment (1D-1E-1F)			$1,198,535

2. Energy Savings (+)/Cost(-):

Date of NISTIR 85-3273 Used for Discount Factors: October 1994

Energy Source	Cost $/MBTU	Saving MBTU/Yr(2)		Annual $ Savings(3)	Discount Factor(4)	Discounted Savings(5)
A. Elec.	$12.82	0		$0	12.02	$0
B. Dist	$6.13	16,549		$101,447	14.23	$1,443,592
C. LPG						
D. Other						
E. Demand Savings		0.0	kW	$0	11.30	$0
F. Total		16,549		$101,447		$1,443,592

3. Non Energy Savings (+) or Cost (-):

A. Annual Recurring (+/-)	$119,261		
(1) Discount Factor (Table A)		11.94	
(2) Discounted Savings/Cost (3A x 3A1)			$1,423,970

B. Non Recurring Savings (+) or Cost (-)

Item	Savings(+) Cost(-)(1)	Year of Occur. (2)	Discount Factor(3)	Discounted Savings(+)Cost(-)(4)
a.				
b.				
c.				
d. Total				

C Total Non Energy Discounted Savings (3A2+3Bd4)	$1,423,970	
4. First Year DollarSavings (2F3+3A+(3Bd1/Economic Life)):	$220,708	
5. Simple Payback (1G/4):	5.43	Years
6. Total Net Discounted Savings (2F5+3C):	$2,867,562	
7. Savings to Investment Ratio (SIR) (6/1G):	2.39	

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DD Form 1391 Detailed Calculations

Comparison of Replacement Piping Alternatives

A typical pipe section is evaluated. The Ordnance Area is an explosives processing area with structures widely separated. All existing piping is underground. Alternatives evaluated include consideration of both above and underground piping replacements. In the above ground option, all piping is above ground except at street and rail crossings. Nominal heights for above ground piping is between 2 and 4 feet to the bottoms of the pipe supports.

Alternatives consider both prefabricated piping systems and built-up piping systems. The costs summarized below are intended exclusively for comparing one type of system against another. Some cost elements that affect all alternatives equally are not considered.

The predominant pipe run in the Ordnance Area, and the pipe sizes used to evaluate alternatives, consists of an 8-inch diameter steam pipe and a 4-inch diameter condensate return pipe. Cost estimates for comparison pipe segments follow.

Above Ground Alternatives		**Comparison First Cost $/LF**
Alternative A1:	22-inch Conduit containing 8-inch Schedule 40 Steam Pipe with 2-inch Insulation and 4-inch Schedule 80 Condensate Pipe with 1-Inch Insulation	$361.58
Alternative A2:	16-inch Conduit containing 8-inch Schedule 40 Steam Pipe with 2-inch Insulation **&** 10-3/4-inch Conduit with 4-inch FRP Condensate Pipe with 1-Inch Insulation	$343.84
Alternative A3:	16-inch Conduit containing 8-inch Schedule 40 Steam Pipe with 2-inch Insulation **&** 10-3/4-inch Conduit with 4-inch Schedule 80 Condensate Pipe with 1-Inch Insulation	$373.59
Alternative A4:	8-inch Schedule 40 Steam Pipe with 2-inch Insulation and Aluminum Jacket - Built Up **&** 4-inch Schedule 80 Condensate Pipe with 1-Inch Insulation & Aluminum Jacket - Built Up	$170.57

Underground Alternatives		**Comparison First Cost $/LF**
Alternative U1:	22-inch Conduit containing 8-inch Schedule 40 Steam Pipe with 2-inch Insulation and 4-inch Schedule 80 Condensate Pipe with 1-Inch Insulation	$343.15
Alternative U2:	16-inch Conduit containing 8-inch Schedule 40 Steam Pipe with 2-inch Insulation **&** 10-3/4-inch Conduit with 4-inch FRP Condensate Pipe with 1-Inch Insulation	$350.47
Alternative U3:	16-inch Conduit containing 8-inch Schedule 40 Steam Pipe with 2-inch Insulation **&** 10-3/4-inch Conduit with 4-inch Schedule 80 Condensate Pipe with 1-Inch Insulation	$380.22

Comparison of Replacement Piping Alternatives

Comparison of Repair Costs

Repairs are more difficult, and costly, for two-pipe conduit systems and for buried pipe systems. Repairs for conduit systems require that the conduit be opened up and the leaking section replaced. For two-pipe conduit systems, both pipes are replaced when one is found leaking. Repair costs are similar to original installation costs. Repairs to single pipe conduit systems are less costly, but still involve cutting through and repairing both the service pipe and the conduit. Repairs to piping in concrete trenches do not incur the expense of re-excavating, nor is there the same level of danger of accidentally digging into the pipe. Repairs to above ground piping systems are the least expensive.

Maintenance costs are higher for systems which contain FRP piping because thermal protective devices installed on all condensate entries must be maintained and defective parts replaced. The installed cost per LF of these protective devices is expensed twice during the life of the piping to represent additional maintenance and repairs required for these systems. Results are indicated below.

For purposes of comparison, frequencies of repair during a pipe segment's lifetime are considered. Results are shown below.

Recommended Replacement Piping Configurations

Descriptions of Alternatives	$/LF	Repairs/ Life	Added Maint	Overall Cost/LF	
Above Ground Alternatives					
Alternative A1	$361.58	1	$0.00	$723.16	
Alternative A2	$343.84	0.75	$28.10	$629.82	
Alternative A3	$373.59	0.5	$0.00	$560.38	
Alternative A4	$170.57	0.25	$0.00	$213.22	← Predominant
Underground Alternatives					
Alternative U1	$343.15	1	$0.00	$686.30	
Alternative U2	$350.47	0.75	$28.10	$641.43	
Alternative U3	$380.22	0.5	$0.00	$570.34	← For Road & Rail Crossings

Table 1
Summary of Piping Replacement Costs
Ordnance Area Steam Distribution
(Road and Rail Crossings Underground)

Pipe Run Description	$/LF	Total LF	Recommended Cost $
MH A5 to MH A11	$150.35	3,538	$531,951
MH D2 to MH D4	$143.16	1,336	$191,263
MH A18 to Bldg 108-20	$141.49	642	$90,837
MH A5 - Bldg 103-40	$60.04	710	$42,631
Bldg 103-6 to MH C3	$120.05	1,394	$167,348
MH B8 to MH B9-1	$89.15	560	$49,925
Total Ordnance Area Piping	**$131.29**	**8,180**	**$1,073,956**
SIOH 5.6%			$60,142
Design 6.0%			$64,437
Total Request	**$146.52**	**8,180**	**$1,198,535**

Refer to Figure 1 for locations of piping replacements

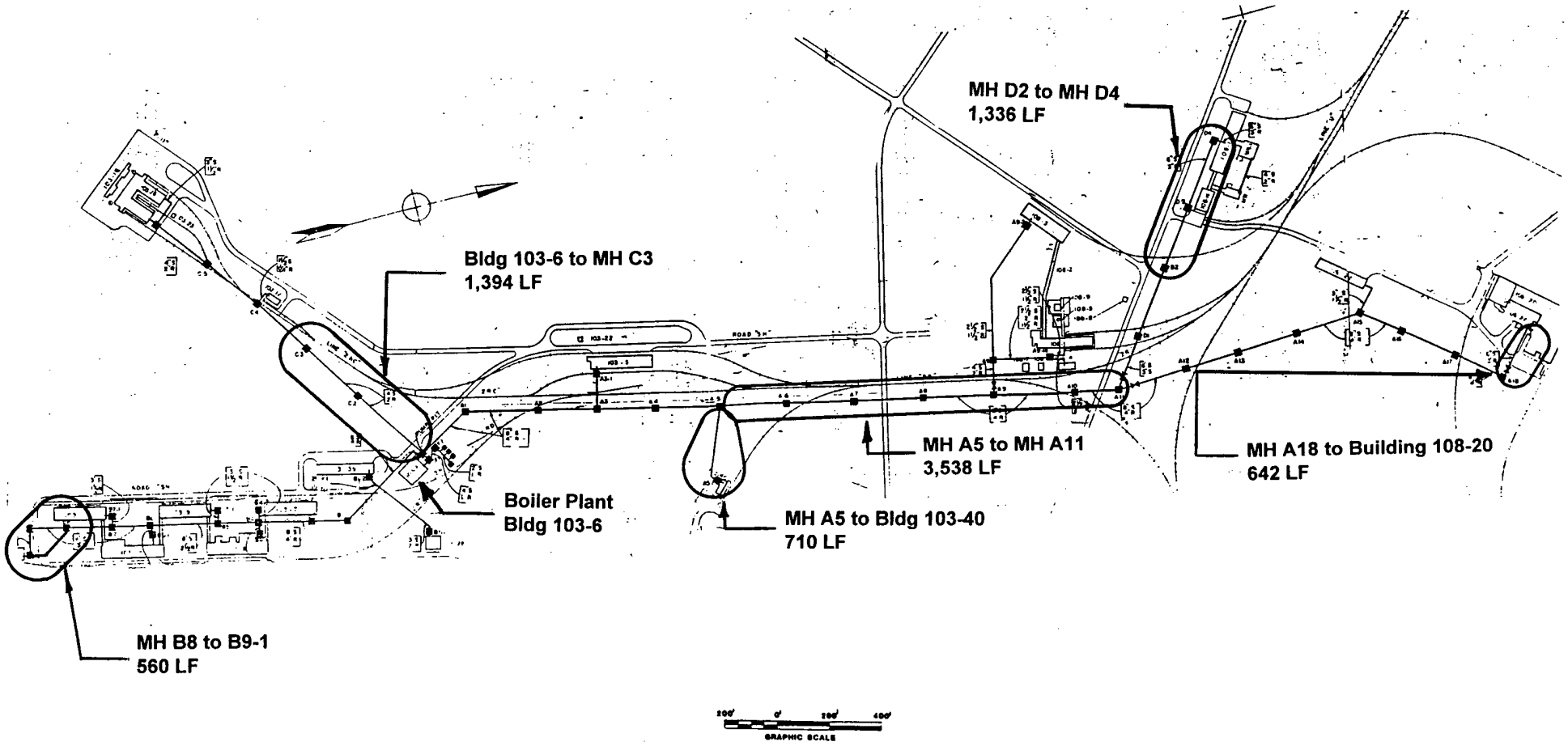

Figure 1
Recommended Steam Distribution System Piping Replacements

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Annual Energy and Maintenance Cost Savings Calculations
Hawthorne Army Ammunition Depot - Ordnance Area

Replacing existing deteriorated piping will save both energy and maintenance costs. Energry savings result from reducing leakage from steam and condensate pipes and from reduced conduction/convection losses due to the installation of replacement piping with proper insulation.

Energy Savings Calculations

Boiler Plant Name Plate Data

Boiler Building 103-6 - Ordnance Area

Boilers: 3 Each, Water Tube Boilers, Style 1 MV Operating Pressure: 112 psig
Boiler Fuel: No. 2 Diesel Fuel Oil (High Sulfur) 345 °F
h_f = 316.94 BTU/Lb h_{fg} = 874.4 BTU/Lb
Coen Burner Natural Gas or Oil at 19,700 CFH of 1,000 BTU/CF Natural Gas
Boiler No. 24 FYR Compak Packaged Burner, Coen File D-6210-1
Boiler No. 25 FYR Compak Packaged Burner, Coen File D-6437
Boiler No. 26 FYR Compak Packaged Burner, Coen File D-6210-2

Burner controls disconnected from flue sensor and automatic controls, burners are trimmed manually

Boiler Feed Pumps: 2 Each, at 20 HP, and 1 Each at 15 HP

Boiler Efficiency Tests:

Boiler No.	Oxygen %	Temp °F	Eff %	Condition
24	9.4%	380	84.8%	Boiler Cold
24	9.3%	480	80.2%	High Fire
25	8.5%	270	85.4%	Boiler Cold
25	7.2%	420	82.3%	High Fire
25	8.5%	270	85.4%	Boiler Cold
25	7.2%	400	82.5%	High Fire
26		Not Operating		

For plant efficiency calculations, the high firing efficiency is used since it more closely follows actual operations.

Boiler Plant Efficiency Calculations

	Steam Plant Bldg 103-6	
Firing (Combustion) Efficiency Test	81.6%	Weighted average of efficiencies
Auxiliary Equipment Uses	-2.0%	allowance for steam ejectors
Radiation Losses @ Figure D-1	-2.0%	
Blowdown Losses (Continuous BD)	-1.5%	
Leaks (Minimal at boiler houses)	-1.0%	Not including distribution leakage
Conduction/Convection	-2.5%	
(Plant only, not including distribution piping; systems rated in "poor" condition due only to age, well maintained.)		
Shut-Down/Cycling Losses	-4.0%	Boilers oversized for current load.
General Equipment Condition	-3.0%	
(Plant only systems rated in "poor" condition due only to age, well maintained.)		
Overall Plant Efficiencies	**65.6%**	

Steam Leakage and Condensate Energy Loss Calculations

Makeup water records are summarized for each of the boiler system. Steam production data is not available.

	Steam Plant Bldg 103-6
Most recent calendar year May '94 through April '95:	1,503,591 Gallons
Calendar Year 1994:	1,138,040 Gallons

The most recent calendar year data is used in steam and condensate energy loss calculations.

These losses include both steam and condensate leaks. Steam leakage represents a much greater energy loss than does the leakage of condensate. This is illustrated below:

Energy needed to raise makeup water from 50°F (raw water temperature) to 200°F, the condensate return temperature: 150.0 BTU per pound water

Energy needed to raise the 200°F condensate to 341°F, the saturation temperature of 105 psig steam: 144.4 BTU per pound water

Energy needed to vaporize 341°F water at 105 psig (heat of evaporation): 877.9 BTU per pound water

Thus, a steam leak includes loss of the useful work the steam can perform (heat of evaporation) and the energy required to heat makeup water to the vaporization temperature, all three of the above elements, or 1,172.2 BTU per pound water

A condensate leak includes only the energy needed to raise raw makeup water to the condensate return temperature, or 150.0 BTU per pound water

The following calculation shows the percent of total steam plant fuel consumption represented by steam and condensate losses where total losses are attributed exclusively to either steam or condensate.

	Steam Plant 103-6	
Energy Losses	**KK BTU/Yr**	**% Total Fuel**
If Leakage is 100% Steam:	14,730	40.8%
If Leakage is 100% Condensate:	3,752	10.4%

Assumes water temp of 50 °F, h_f = 18.1 BTU/LB ; Fuel Oil at 138,700 BTU/Gallon

Based on field observations, it appears that most of the makeup water loss is composed of condensate that is not returned to the central plants. There are only a few steam leaks. Conservatively, then, assume 10% of the losses in the Ordnance Area are from condensate. Blowdown is included in makeup water requirements and constitutes about 2% of the total steam flow. This use is subtracted from the loss calculations below. The annual energy savings from repairs to the distribution systems are:

	Ordnance Area Steam Plant 103-6
Energy Losses	**KK BTU/Yr**
Loss from Steam Leakage	1,473
Loss from Condensate Leakage	3,377
Thermal Losses	4,850
Boiler Plant Efficiency	65.6%
Makeup Water Fuel Uses	7,396
Blowdown Loss (2% of fuel input)	721
Leakage Fuel Losses (No 2 Fuel Oil)	**6,675**

Significant additional losses occur from poorly insulated steam and condensate lines. Leakage of steam and condensate has wetted the insulation (if present) to such an extent that little insulating value remains.

Energy Savings from Piping Insulation Losses

Existing piping is deteriorated and leaks have destroyed the value of insulation installed on existing piping. Insulation thermal losses are determined for existing and proposed future piping systems. Detailed calculations follow. Results are summarized here:

Energy Savings	**Ordnance Area Steam Plant 103-6 KK BTU/Yr**
Load Saved (Heating Season Only)	6,475
Boiler Plant Efficiency	65.6%
Insulation Savings (No 2 Fuel Oil)	**9,875**
Total Fuel Oil Savings	**16,549**

Operation and Maintenance Cost Savings

The proposed new piping systems will reduce operation and maintenance costs significantly. Cost savings for each area are determined below.

Proposed piping replacements will be predominantly above ground. Installation above ground should reduce the magnitude chronic breaks experienced along certain stretches of piping. Repairs will be performed on piping without having to either dig up conduit sections or to enter manholes.

With the newly enforced confined space entry procedures, limiting access requirements into manholes should significantly reduce costs as an extra worker will not be required to be present to assist in evacuations.

Overall, the piping replacements in the Ordnance Area are expected to save about 3/4 of present maintenance costs according to maintenance supervisors. During the last year for which records are available, about 4,300 hours per year were spent on preventive maintenance, service calls and on major repairs. Based on a steamfitter rate of $42.33 per Hour and helper rate of $31.63 (Means Steamfitter & Helper, location adjusted) and 3/4 of the total maintenance hours, savings are expected to total:

4,300 hours year x 3/4 x $36.98 per hour = $119,261 per year, including overhead.

Thermal Loss Calculations for New and Deteriorated Existing Steam Distribution & Condensate Piping

Piping Systems

Source: Siddiqui, M.K., Calculations for Insulated Piping Systems, Heating/Piping/Air Conditioning, November 1994

Piping Layout (1=AG; 2=UG):	1 for above ground installation
Outer Pipe Diameter (Inches):	See Table below for actual sizes
Service Temperature:	HP Steam 338°F, LP Steam 250°F, Condensate 200°F
Insulation Conductivity at TM1 (BTUH-IN/SF-°F):	0.31 at 200°F
Insulation Conductivity at TM2 (BTUH-IN/SF-°F):	0.36 at 300°F
Pipe Orientation (1=Horizontal; 2=Vertical):	Normally Horizontal
Ambient Air Temperature (°F):	Average Winter Temperature = 23.4°F from TM 5-785 Bin Data for temps below 72°F (winter)
Wind Speed (MPH):	3.3 from TM 5-785 Bin Data
Surface Emittance:	0.20 for oxidized aluminum jacket (Owens Corning advice)
Average Annual Soil Temperature:	40.0°F from 1989 HVAC Handbook (ASHRAE)
Thermal Conductivity of Soil (BTUH-In/SF-°F):	12.0 assumed based on Table 6, 22.13 1993 ASHRAE Fundamentals Handbook
Burial Depth to Centerline of Pipe (FT):	4.0 FT
Insulation Thickness (Inches):	See below, based on CEGS's for above ground, trench systems and conduit systems.
Air Space (Inches):	See below for various pipe sizes
Inner Diameter of Pipe (Inches):	See below for pipe size and service
Thermal Conductivity for Direct Burried Pipe (BTU-In/(Hr-SF-°F):	Red Brass = 2,784 FRP = 2.30

Nominal Pipe Size	**1**	**1.25**	**1.5**	**2**	**2.5**	**3**	**4**	**5**	**6**	**8**
Pipe Diameter Schedule 40 for Steam Service										
Pipe OD (Inches)	1.182	1.52	1.755	2.221	2.672	3.284	4.263	5.305	6.345	8.303
Pipe ID (Inches)	1.049	1.38	1.61	2.067	2.469	3.068	4.026	5.047	6.065	7.981
Insulation Thickness (Mineral Wool)										
Above Ground (Inches)	2.5	2.5	2.5	3.5	3.5	4.0	4.0	4.0	4.5	4.5
Pipe Trench (Inches)	2.0	2.0	2.5	2.5	2.5	3.0	3.0	3.0	3.5	3.5
UG Conduit (Inches)	2.0	2.0	2.0	2.5	2.5	3.0	3.0	3.0	3.5	3.5
Conduit Casing (Inch)	6.625	6.625	6.625	8.625	8.625	10.750	12.750	12.750	16.000	18.0
Air Space (Inches)	0.813	0.688	0.563	0.813	0.563	0.875	1.375	0.875	1.500	1.500
Pipe Diameter Schedule 80 for Condensate Service										
Pipe OD (Inches)	1.136	1.469	1.7	2.157	2.599	3.2	4.163	5.188	6.193	8.125
Pipe ID (Inches)	0.957	1.278	1.5	1.939	2.323	2.9	3.826	4.813	5.761	7.625
Insulation Thickness (Mineral Wool)										
Above Ground (Inches)	2.0	2.0	2.0	2.0	2.0	2.5	2.5	-	-	-
Pipe Trench (Inches)	1.5	1.5	1.5	1.5	1.5	2.0	2.0	-	-	-
UG Conduit (Inches)	1.5	1.5	1.5	1.5	1.5	2.0	2.0	-	-	-
Conduit Casing (Inch)	6.625	6.625	6.625	8.625	8.625	10.750	10.750	-	-	-
Air Space (Inches)	1.313	1.188	1.063	1.813	1.563	1.875	1.375	-	-	-

Thermal Loss Calculations for New and Deteriorated Existing Steam Distribution & Condensate Piping

Nominal Pipe Size	1	1.25	1.5	2	2.5	3	4	5	6	8	2 LPS		2.5 LPS				
Nominal Size Sch 40 for Steam Service, New Piping																	
Above Ground (BTUH/LF)	34.6	39.2	42.3	40.4	44.6	46.6	54.3	62.3	65.0	78.0	-	-	-	-	-	-	-
Pipe Trench (BTUH/LF)	37.6	42.9	41.5	47.3	52.7	53.9	63.5	73.5	75.3	91.2	34	-	37.9	-	-	-	-
UG Conduit (BTUH/LF)	34.8	37.5	42.5	43.3	48.0	49.2	57.7	66.1	67.9	81.6	-	-	-	-	-	-	-
Nominal Size Sch 80 for Condensate Service, New Piping																	
Above Ground (BTUH/LF)	18.9	23.9	25.9	29.8	33.4	33.4	39.7	-	-	-	-	-	-	-	-	-	-
Pipe Trench (BTUH/LF)	23.3	26.9	29.3	33.9	38.3	37.2	44.5	-	-	-	-	-	-	-	-	-	-
UG Conduit (BTUH/LF)	20.9	24.0	26.0	30.1	33.7	32.7	38.7	-	-	-							
Nominal Size Sch 40 for Steam Service, Existing, Deteriorated Piping											**2 LPS**		**2.5 LPS**				
Above Ground (BTUH/LF)	81.8	98.2	109.5	131.7	152.9	181.5	226.9	274.8	322.3	411.1	-	-	-	-	-	-	-
Pipe Trench (BTUH/LF)	75.6	90.5	100.8	120.9	140.1	166.0	207.0	250.5	293.5	374.0	86.6	-	100.4	-	-	-	-
UG Conduit (BTUH/LF)	67.2	79.2	86.9	102.5	115.8	134.7	163.8	189.0	217.7	263.4	-	-	-	-	-	-	-
Nominal Size Sch 80 for Condensate Service, Existing, Deteriorated Piping													**Buried Bare Pipe**				
Above Ground (BTUH/LF)	43.5	52.3	58.3	70.1	81.4	96.6	120.8	-	-	-	**1.5**	**1.5**	**2**	**2**	**3**	**3**	**4**
Pipe Trench (BTUH/LF)	39.9	47.8	53.2	63.8	73.9	87.5	109.2	-	-	-	FRP	Brass	FRP	Brass	FRP	FRP	Brass
UG Conduit (BTUH/LF)	90.3	106.5	116.1	139.8	154.0	175.8	197.0	-	-	-	201.4	232.2	221.6	244.9	251.0	270.4	290.0

Ordnance Area Thermal Loss Savings from Selected Piping Replacements

(Refer to results of Pipe Heat Loss Calculations)

Ordnance Area	Service	Proposed Placement	Dia	LF	Current BTUH/LF	Proposed BTUH/LF	Heat Load Saved BTUH	KK BTU/Yr Saved
MH A5 to Bldg 103-40	COND	AG	2	**355**	116.1	25.9	32,021	140.3
Bldg 103-6 to MH C3	COND	AG	2	**627**	139.8	29.8	68,970	302.1
MH D2 to MH D4	COND	AG	3	**180**	175.8	33.4	25,632	112.3
MH A5 to MH A11	COND	AG	4	**1,769**	197.0	39.7	278,264	1218.8
MH A18 to Bldg 108-20	COND	AG	2	**30**	116.1	25.9	2,706	11.9
MH B8 to MH B9-1	COND	AG	2	**250**	139.8	29.8	27,500	120.5
MH A5 to Bldg 103-40	STM	AG	3	**355**	134.7	46.6	31,276	137.0
Bldg 103-6 to MH C3	STM	AG	4	**627**	163.8	54.3	68,657	300.7
MH D2 to MH D4	STM	AG	6	**180**	322.3	65.0	46,314	202.9
MH A5 to MH A11	STM	AG	8	**1,769**	411.1	78.0	589,254	2580.9
MH A18 to Bldg 108-20	STM	AG	3	**30**	154.0	48.0	3,180	13.9
MH B8 to MH B9-1	STM	AG	4	**250**	163.8	54.3	27,375	119.9
Bldg 103-6 to MH C3	COND	UG Conduit	2	**70**	139.8	30.1	7,679	33.6
MH A18 to Bldg 108-20	COND	UG Conduit	3	280	175.8	32.7	40,068	175.5
MH D2 to MH D4	COND	UG Conduit	3	**488**	175.8	32.7	69,833	305.9
MH A5 to MH A11	COND	UG Conduit	4	**90**	197.0	38.7	14,247	62.4
MH B8 to MH B9-1	COND	UG Conduit	2	**30**	139.8	30.1	3,291	14.4
Bldg 103-6 to MH C3	STM	UG Conduit	4	**70**	163.8	57.7	7,427	32.5
MH A18 to Bldg 108-20	STM	UG Conduit	6	280	217.7	67.9	41,944	183.7
MH D2 to MH D4	STM	UG Conduit	6	**488**	217.7	67.9	73,102	320.2
MH A5 to MH A11	STM	UG Conduit	8	**90**	263.4	81.6	16,362	71.7
MH B8 to MH B9-1	STM	UG Conduit	4	**30**	163.8	57.7	3,183	13.9

Note: Current placement is buried conduit systems in very poor repair.

Total Thermal Loss Load Saved from Replacing Piping (KK BTU/Year) **6,475**

Boiler Plant Efficiency 65.6%

Fuel Oil Savings of Piping Thermal Losses (kk BTU/Year) **9,875**

CONSTRUCTION COST ESTIMATE			Date Prepared: September-95		Sheet: 1 of 7		
Project: ECIP Modernize Ordnance Area Steam Distribution			Project No.: PN-42166		Basis for Estimate: Code A (no design competed)		
Location: Hawthorne Army Ammunition Depot, Nevada							
Engineer-Architect: Keller & Gannon							
Drawing No.: **Replace Pipes from MH A5 to MH A11**			Estimator: **DLN**		Checked By: **BIH**		
Line Item	Quantity		Labor		Material		Total Cost
	No. Units	Unit Meas.	Per Unit	Total	Per Unit	Total	
(**Aboveground piping:** built-up steam & condensate lines with insulation & aluminum jackets)							
8-inch/4-inch	1,769	LF	$68.84	$121,776	$60.52	$107,055	$228,831
SUPPORTS	55	EA	$337.01	$18,674	$290.00	$16,069	$34,744
STEAM VALVES							
8-inch	5	EA	$344.50	$1,722	$2,282.20	$11,411	$13,134
6-inch	1	EA	$292.88	$293	$1,448.76	$1,449	$1,742
4-inch	1	EA	$202.53	$203	$929.92	$930	$1,132
3-inch	1	EA	$146.75	$147	$727.35	$727	$874
COND VALVES							
4-inch	5	EA	$202.53	$1,013	$929.92	$4,650	$5,662
3-inch	1	EA	$146.75	$147	$727.35	$727	$874
2-inch	1	EA	$99.75	$100	$182.27	$182	$282
1 1/2-inch	2	EA	$76.98	$154	$139.58	$279	$433
STEAM TEES							
8-inch	10	EA	$371.13	$3,711	$162.91	$1,629	$5,340
COND TEES							
4-inch	13	EA	$251.53	$3,270	$84.92	$1,104	$4,374
45 ELBOWS (COMMON)							
8-inch/4-inch	2	EA	$441.09	$882	$164.40	$329	$1,211
6-inch/3-inch	1	EA	$347.39	$347	$119.21	$119	$467
90 ELBOW (COMMON)							
8-inch/4-inch	24	EA	$441.09	$10,586	$199.51	$4,788	$15,374
6-inch/3-inch	1	EA	$347.39	$347	$132.71	$133	$480
4-inch/2-inch	2	EA	$260.24	$520	$38.80	$78	$598
3-inch/2-inch	2	EA	$207.29	$415	$61.14	$122	$537
ELBOWS (SINGLE-COND)							
1 1/2-inch	42	EA	$86.54	$3,635	$23.63	$992	$4,627
ANCHORS							
8-inch/4-inch	4	EA	$60.50	$242	$61.82	$247	$489
Miscellaneous Fittings							
2-inch DRIP NIPPLE	7	EA	$21.50	$151	$33.00	$231	$382
1 1/2-inch'Steam Trap Assembly	7	EA	$168.12	$1,177	$1,000.50	$7,004	$8,180
STM GAGE	1	EA	$7.30	$7	$16.50	$17	$24
PRESSURE GAGE	1	EA	$7.30	$7	$16.50	$17	$24

CONSTRUCTION COST ESTIMATE			Date Prepared: September-95		Sheet: 2 of 7		
Project: ECIP Modernize Ordnance Area Steam Distribution			Project No.: PN-42166		Basis for Estimate: Code A (no design competed)		
Location: Hawthorne Army Ammunition Depot, Nevada							
Engineer-Architect: Keller & Gannon							
Drawing No.: **Replace Pipes from MH A5 to MH A11**			Estimator: **DLN**		Checked By: **BIH**		
Line Item	Quantity		Labor		Material		Total Cost
	No. Units	Unit Meas.	Per Unit	Total	Per Unit	Total	
(BELOW-GRADE PIPING: STM PIPE IN CONDUIT & COND PIPE IN CONDUIT)							
8-inch/4-inch	90	LF	$93.00	$8,370	$80.01	$7,201	$15,571
TRENCH/BACKFILL							
DIR-LAWN	40	LF	$7	$285	$0.00	$0	$285
CONC-ROAD	50	LF	$24	$1,189	$0.00	$0	$1,189
RR TRACKS	2	EA	$750.00	$1,500	$0.00	$0	$1,500
STEAM PITS	5	EA	$1,450	$7,250	$4,816	$24,080	$31,330
Subtotal				$188,120		$191,570	$379,707
Nevada Sales Tax	3.75%					$7,184	$7,184
Subtotal							$386,891
Contractor Overhead & Profit	25.0%						$96,723
Subtotal							$483,613
Estimating Contingency	10.0%						$48,361
Total Probable Construction Cost							**$531,975**
Average Cost per Linear Foot Including Steam and Condensate Piping & Fittings							$150.36

CONSTRUCTION COST ESTIMATE			Date Prepared: September-95		Sheet: 3 of 7		
Project: ECIP Modernize Ordnance Area Steam Distribution			Project No.: PN-42166		Basis for Estimate: Code A (no design competed)		
Location: Hawthorne Army Ammunition Depot, Nevada							
Engineer-Architect: Keller & Gannon							
Drawing No.: **Replace Pipes from MH D2 to MH D4**			Estimator: **DLN**		Checked By: **BIH**		
Line Item	Quantity		Labor		Material		Total Cost
	No. Units	Unit Meas.	Per Unit	Total	Per Unit	Total	
(**Aboveground piping:** built-up steam & condensate lines with insulation & aluminum jackets)							
6-inch/3-inch	180	LF	$58.38	$10,508	$45.12	$8,121	$18,629
SUPPORTS	7	EA	$337.01	$2,431	$290.00	$2,092	$4,523
STEAM VALVES							
8-inch	1	EA	$344.50	$344	$2,282.20	$2,282	$2,627
6-inch	2	EA	$292.88	$586	$1,448.76	$2,898	$3,483
COND VALVES							
3-inch	2	EA	$146.75	$294	$727.35	$1,455	$1,748
1 1/2-inch	8	EA	$76.98	$616	$139.58	$1,117	$1,732
STEAM TEES							
6-inch	3	EA	$310.38	$931	$105.76	$317	$1,248
2 1/2-inch	2	EA	$141.04	$282	$47.23	$94	$377
COND TEES							
3-inch	4	EA	$188.80	$755	$58.35	$233	$989
1 1/2-inch	1	EA	$112.94	$113	$37.58	$38	$151
90 ELBOW (COMMON)							
6-inch/3-inch	8	EA	$347.39	$2,779	$132.71	$1,062	$3,841
ELBOWS (SINGLE-COND)							
1 1/2-inch	17	EA	$86.54	$1,471	$23.63	$402	$1,873
ANCHORS							
6-inch/3-inch	2	EA	$59.62	$119	$53.37	$107	$226
GUIDES							
6-inch/3-inch	3	EA	$27.65	$83	$219.00	$657	$740
Miscellaneous Fittings							
2-inch DRIP NIPPLE	3	EA	$21.50	$65	$33.00	$99	$164
1 1/2-inch'Steam Trap Assembly	3	EA	$168.12	$504	$1,000.50	$3,002	$3,506
BELOW-GRADE PIPING: STM & COND PIPE IN CONDUIT							
6-inch/3-inch	488	LF	$79.77	$38,928	$70.71	$34,506	$73,434
TRENCH/BACKFILL							
DIR-LAWN	458	LF	$7.12	$3,261	$0.00	$0	$3,261
CONC-ROAD	30	LF	$23.78	$713	$0.00	$0	$713
R/R TRACK	1	EA	$750.00	$750	$0.00	$0	$750
STEAM PITS	2	EA	$1,450	$2,900	$4,816.00	$9,632	$12,532
Subtotal				$68,433		$68,113	$136,546
Nevada Sales Tax	3.75%					$2,554	$2,554
Subtotal							$139,100
Contractor Overhead & Profit	25.0%						$34,775
Subtotal							$173,875
Estimating Contingency	10.0%						17387.52
Total Probable Construction Cost							**$191,263**
Average Cost per Linear Foot Including Steam and Condensate Piping & Fittings							$143.16

CONSTRUCTION COST ESTIMATE

Date Prepared: September-95 | Sheet: 4 of 7

Project: ECIP Modernize Ordnance Area Steam Distribution | Project No.: PN-42166 | Basis for Estimate: Code A (no design competed)

Location: Hawthorne Army Ammunition Depot, Nevada

Engineer-Architect: Keller & Gannon

Drawing No.: **Replace Pipes from MH A18 to Bldg 108-20** | Estimator: **DLN** | Checked By: **BIH**

Line Item	Quantity No. Units	Quantity Unit Meas.	Labor Per Unit	Labor Total	Material Per Unit	Material Total	Total Cost
(**Aboveground piping:** built-up steam & condensate lines with insulation & aluminum jackets)							
2 1/2-inch / 1 1/2-inch	30	LF	$32.60	$978	$18.65	$559	$1,538
SUPPORTS	10	EA	$337.01	$3,370	$290.00	$2,900	$6,270
STEAM VALVES							
6-inch	1	EA	$292.88	$293	$1,448.76	$1,449	$1,742
COND VALVES							
3-inch	1	EA	$146.75	$147	$727.35	$727	$874
90 ELBOW (COMMON)							
6-inch/3-inch	4	EA	$347.39	$1,390	$132.71	$531	$1,920
GUIDES							
6-inch/3-inch	1	EA	$27.65	$28	$219.00	$219	$247
Miscellaneous Fittings							
2-inch DRIP NIPPLE	1	EA	$21.50	$22	$33.00	$33	$55
1 1/2-inch'Steam Trap Assembly	1	EA	$168.12	$168	$1,000.50	$1,001	$1,169
(BELOW-GRADE PIPING: STM PIPE IN CONDUIT & CONDENSATE PIPE IN CONDUIT							
6-inch/3-inch	291	LF	$79.77	$23,213	$70.71	$20,577	$43,790
TRENCH/BACKFILL							
DIRT & LAWN	30	LF	$7.12	$214	$0.00	$0	$214
R/R TRACK	1	EA	$750.00	$750	$0.00	$0	$750
STEAM PITS	1	EA	$1,450	$1,450	$4,816	$4,816	$6,266
Subtotal				$32,021		$32,812	$64,833
Nevada Sales Tax	3.75%					$1,230	$1,230
Subtotal							$66,063
Contractor Overhead & Profit	25.0%						$16,516
Subtotal							$82,579
Estimating Contingency	10.0%						$8,258
Total Probable Construction Cost							**$90,837**
Average Cost per Linear Foot Including Steam and Condensate Piping & Fittings							$141.49

CONSTRUCTION COST ESTIMATE

Date Prepared: September-95 | Sheet: 5 of 7

Project: ECIP Modernize Ordnance Area Steam Distribution | Project No.: PN-42166 | Basis for Estimate: Code A (no design competed)

Location: Hawthorne Army Ammunition Depot, Nevada

Engineer-Architect: Keller & Gannon

Drawing No.: **Replace Piping from MH A5 - Bldg 103-40** | Estimator: **DLN** | Checked By: **BIH**

Line Item	Quantity No. Units	Quantity Unit Meas.	Labor Per Unit	Labor Total	Material Per Unit	Material Total	Total Cost
(**Aboveground piping:** built-up steam & condensate lines with insulation & aluminum jackets)							
3-inch/1 1/2-inch	355	LF	$34.93	$12,400	$19.73	$7,003	$19,403
SUPPORTS	12	EA	$337.01	$4,044	$290.00	$3,480	$7,524
STEAM VALVES							
3-inch	1	EA	$146.75	$147	$727.35	$727	$874
COND VALVES							
1 1/2-inch	1	EA	$76.98	$77	$139.58	$140	$217
STEAM TEES							
3-inch	2	EA	$190.90	$382	$49.85	$100	$482
45 ELBOWS (COMMON)							
3-inch/2-inch	2	EA	$207.29	$415	$59.74	$119	$534
90 ELBOW (COMMON)							
3-inch/1 1/2-inch	4	EA	$207.29	$829	$61.14	$245	$1,074
ELBOWS (SINGLE-COND)							
1 1/2-inch	2	EA	$86.54	$173	$23.63	$47	$220
GUIDES							
3-inch/1 1/2-inch	1	EA	$24.15	$24	$147.50	$148	$172
Miscellaneous Fittings							
2-inch DRIP NIPPLE	1	EA	$21.50	$22	$33.00	$33	$55
Subtotal				$18,512		$12,041	$30,553
Nevada Sales Tax	3.75%					$452	$452
Subtotal							$31,005
Contractor Overhead & Profit	25.0%						$7,751
Subtotal							$38,756
Estimating Contingency	10.0%						$3,876
Total Probable Construction Cost							**$42,631**
Average Cost per Linear Foot Including Steam and Condensate Piping & Fittings							$60.04

CONSTRUCTION COST ESTIMATE					Date Prepared September-95		Sheet 6 of 7
Project: ECIP Modernize Ordnance Area Steam Distribution				Project No. PN-42166	Basis for Estimate: Code A (no design competed)		
Location: Hawthorne Army Ammunition Depot, Nevada							
Engineer-Architect: Keller & Gannon							
Drawing No. **Replace Pipes from Building 103-6 to MH C3**				Estimator **DLN**	Checked By **BIH**		

Line Item	Quantity No. Units	Quantity Unit Meas.	Labor Per Unit	Labor Total	Material Per Unit	Material Total	Total Cost
(**Aboveground piping:** built-up steam & condensate lines with insulation & aluminum jackets)							
4-inch/ 2-inch	627	LF	$43.27	$27,132	$17.94	$11,247	$38,378
SUPPORTS	28	EA	$337.01	$9,297	$290.00	$8,001	$17,298
STEAM VALVES							
4-inch	2	EA	$202.53	$405	$929.92	$1,860	$2,265
COND VALVES							
2-inch	2	EA	$99.75	$200	$182.27	$365	$564
1 1/2-inch	4	EA	$76.98	$308	$139.58	$558	$866
STEAM TEES							
4-inch	2	EA	$215.69	$431	$62.14	$124	$556
COND TEES							
2-inch	4	EA	$139.10	$556	$41.87	$167	$724
90 ELBOW (COMMON)							
4-inch/2-inch	8	EA	$260.24	$2,082	$38.80	$310	$2,392
ELBOWS (SINGLE-COND)							
1 1/2-inch	5	EA	$86.54	$433	$23.63	$118	$551
ANCHORS							
4-inch/2-inch	2	EA	$59.46	$119	$49.08	$98	$217
GUIDES							
4-inch/2-inch	2	EA	$27.65	$55	$219.00	$438	$493
Miscellaneous Fittings							
2-inch DRIP NIPPLE	2	EA		$0		$0	$0
1 1/2-inch'Steam Trap Assembly	2	EA	$168.12	$336	$1,000.50	$2,001	$2,337
STM GAGE	1	EA	$140.00	$140	$2,025.00	$2,025	$2,165
PRESSURE GAGE	1	EA	$7.30	$7	$16.50	$17	$24
BELOW-GRADE PIPING: STM PIPE IN CONDUIT & COND PIPE IN CONDUIT							
4-inch/ 2-inch	70	LF	$65.52	$4,586	$56.29	$3,940	$8,527
TRENCH/BACKFILL							
DIRT & LAWN	10	LF	$7.12	$71	$0.00	$0	$71
CONCRETE ROAD	60	LF	$23.78	$1,427	$0.00	$0	$1,427
R/R TRACK	4	EA	$750.00	$3,000	$0.00	$0	$3,000
STEAM PITS	6	EA	$1,450	$8,700	$4,816.00	$28,896	$37,596
Subtotal				$59,286		$60,165	$119,451
Nevada Sales Tax	3.75%					$2,256	$2,256
Subtotal							$121,708
Contractor Overhead & Profit	25.0%						$30,427
Subtotal							$152,135
Estimating Contingency	10.0%						$15,213
Total Probable Construction Cost							**$167,348**
Average Cost per Linear Foot Including Steam and Condensate Piping & Fittings							$120.05

CONSTRUCTION COST ESTIMATE

Date Prepared: September-95 | Sheet 7 of 7

Project: ECIP Modernize Ordnance Area Steam Distribution | Project No. PN-42166 | Basis for Estimate: Code A (no design competed)

Location: Hawthorne Army Ammunition Plant, Nevada

Engineer-Architect: Keller & Gannon

Drawing No.: **Replace Pipes from MH B8 to MH B9-1** | Estimator: **DLN** | Checked By: **BIH**

Line Item	Quantity No. Units	Quantity Unit Meas.	Labor Per Unit	Labor Total	Material Per Unit	Material Total	Total Cost
(**Aboveground piping:** built-up steam & condensate lines with insulation & aluminum jackets)							
4-inch/ 2-inch	250	LF	$43.27	$10,818	$17.94	$4,484	$15,302
SUPPORTS	7	EA	$337.01	$2,359	$290.00	$2,030	$4,389
STEAM VALVES							
4-inch	1	EA	$202.53	$203	$929.92	$930	$1,132
COND VALVES							
2-inch	1	EA	$99.75	$100	$182.27	$182	$282
45 ELBOWS (COMMON)							
4-inch/2-inch	2	EA	$260.24	$520	$42.70	$85	$606
90 ELBOW (COMMON)							
4-inch/2-inch	4	EA	$260.24	$1,041	$38.80	$155	$1,196
ELBOWS (SINGLE-COND)							
2-inch	2	EA	$103.65	$207	$31.32	$63	$270
1 1/2-inch	5	EA	$86.54	$433	$23.63	$118	$551
GUIDES							
4-inch/2-inch	1	EA	$25.80	$26	$208.50	$209	$234
Miscellaneous Fittings							
2-inch DRIP NIPPLE	1	EA	$21.50	$22	$33.00	$33	$55
1 1/2-inch'Steam Trap Assembly	1	EA	$168.12	$168	$1,000.50	$1,001	$1,169
BELOW-GRADE PIPING: STM PIPE IN CONDUIT & CONDENSATE PIPE IN CONDUIT							
4-inch/ 2-inch	30	LF	$62.09	$1,863	$56.29	$1,689	$3,551
TRENCH/BACKFILL							
CONCRETE ROAD	30	LF	$23.78	$713	$0.00	$0	$713
STEAM PITS	1	EA	$1,450	$1,450	$4,816.00	$4,816	$6,266
Subtotal				$19,922		$15,795	$35,717
Nevada Sales Tax	3.75%					$592	$592
Subtotal							$36,309
Contractor Overhead & Profit	25.0%						$9,077
Subtotal							$45,387
Estimating Contingency	10.0%						$4,539
Total Probable Construction Cost							**$49,925**
Average Cost per Linear Foot Including Steam and Condensate Piping & Fittings							$89.15